**Investigating the Multidimensionality of Need Fulfillment: A Bifactor Exploratory Structural Equation Modeling Representation**

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**Abstract**

This article assesses the multidimensionality of the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS) using bifactor-exploratory structural equation modeling (bifactor-ESEM). The first study relies on a sample of community adults ($N$ = 2301), and revealed the superiority of a bifactor-ESEM representation, supporting the six-factor structure of BPNSFS ratings, and the presence of a single continuum of need fulfillment, relative to two distinct dimensions reflecting need satisfaction and frustration. These results were replicated in a second representative sample ($N$ = 504), as well as across gender, and found no evidence of differential item functioning as a function of age. Relative to males, females presented higher levels of relatedness satisfaction, and lower levels of competence satisfaction. Finally, autonomy frustration decreased with age, whereas competence satisfaction and frustration presented opposite curvilinear tendencies showing that the fulfillment of this need increased sharply for younger participants, a tendency that became less pronounced with age.

*Keywords:* Basic Psychological Need Satisfaction and Frustration Scale (BPNSF); bifactor; Exploratory Structural Equation Modeling; ESEM; measurement invariance; need frustration; need satisfaction; gender, age.

This study is a substantive-methodological synergy (Marsh & Hau, 2007) in which new and evolving methodological approaches are applied to substantively important research questions. Substantively, this study pertains to the theory of basic psychological needs (Vansteenkiste, Niemiec, & Soenens, 2010), a critical component of Self-Determination Theory (SDT; Deci & Ryan, 1985, 2000). This theory posits that optimal psychological functioning and wellbeing are anchored into the satisfaction of the basic psychological needs for autonomy, competence, and relatedness, whereas the frustration of these needs is purported to lie at the core of adaptation difficulties and ill-being. In particular, this theory assumes that the satisfaction and frustration of these three basic psychological needs are distinct components of psychological functioning. Methodologically, this study tests this assumption through the application of the new bifactor exploratory structural equation modeling (bifactor-ESEM) framework (Morin, Arens, & Marsh, 2016a) to responses provided by adults to the newly developed Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS; Chen et al., 2015). Furthermore, in order to document the generalizability of our findings, we verify the extent to which the results generalize across two distinct samples of adults, their measurement invariance as a function of gender, and the effects of age on BPNSFS responses.

**Basic Psychological Needs Theory**

According to SDT, three basic psychological needs are hypothesized to represent the essential nutriments of optimal functioning and wellbeing (Deci & Ryan, 1985, 2000). The need for autonomy refers to feelings of volition, choice, and psychological freedom, whereas the need for competence refers to the experience of effectiveness in one's pursuits and of capability in mastering challenges. Finally, the need for relatedness describes feelings of connection, reciprocity, and embeddedness with significant others. So far, many studies have supported the hypothesis that satisfaction of these basic psychological needs tends to be associated with higher levels of psychological wellbeing (Church et al., 2013; Deci et al., 2001), as well as many indicators of optimal psychological functioning including intrinsic motivation (Krijgsman et al., 2017) and positive identity development (Luyckx, Vansteenkiste, Goossens, & Duriez, 2009). Recently, the possible empirical differentiation between the satisfaction of these basic psychological needs and their frustration (or thwarting) has received considerable attention (Vansteenkiste & Ryan, 2013). Need frustration is proposed to go beyond the simple lack of need satisfaction, and to directly reflect feelings that one's basic psychological need are actively thwarted or frustrated within one's environment. In turn, need frustration is assumed to represent a key driver of psychological ill-being, psychopathologies and other adaptation difficulties (Bartholomew, Ntoumanis, Ryan, Bosch, & Thøgersen-Ntoumani, 2011; Ryan, Deci, Grolnick, & La Guardia, 2006; Vansteenkiste & Ryan, 2013). Based on these recent development, it thus appears critical, in order to achieve a complete understanding of psychological need fulfillment, to simultaneously consider both the satisfaction and the frustration of these three basic needs.

These theoretical propositions have naturally led to the development of a variety of measures to empirically operationalize the constructs of need satisfaction and frustration, namely the Psychological Need Thwarting Scale (Bartholomew et al., 2011), the Balanced Measure of Psychological Needs (Sheldon & Hilpert, 2012) and the Need Satisfaction and Frustration Scale (Longo, Gunz, Curtis, & Farsides, 2016). However, the first of these measures only focused on need frustration. In contrast, the second of these measures, despite relying on a mixture of positively- and negatively-worded items, was essentially developed to assess need satisfaction while incorporating method factors to account for wording effects (e.g., Marsh, Scalas, & Nagengast, 2010), which are known to limit cross-cultural generalizability (Schmitt & Allik, 2005; Watkins & Cheung, 1995). Finally, the last measure is specific to the work and education contexts rather than to focus on general need satisfaction and frustration, which is the focal point of the present investigation. For these reasons, we retained the Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS), which was developed to overcome some of the aforementioned issues in the context of a large-scale international collaboration project (Chen et al., 2015). Chen et al.'s (2015) results supported the a priori six-factor structure of the BPNSFS ratings across four samples of Belgian (Dutch-speaking), Chinese (Chinese-speaking), Americans (English-speaking), and Peruvian (Spanish-speaking) respondents, as well as their predictive and discriminant validity. Since then, these results have been replicated in samples of Portuguese (Cordeiro, Paixão, Lens, Lacante, & Luckx, 2016a) and Japanese participants (Nishimura, & Suzuki, 2016), making this measure well-suited to our investigation.

**The Dimensionality Issue**

As can be expected, the newness of this extended representation of SDT basic psychological needs theory means that so far, examination of the underlying structure of measures of need satisfaction and frustration remains limited. In particular, a key limitation of research in this area is the reliance on the assumption that the subscales forming these measures are perfectly unidimensional psychometrically, which is intimately related to the independent cluster assumption of confirmatory factor analyses (CFA). Typically, psychometric research in this area has tended to support the a priori unidimensional six-factor structure (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration), sometimes based on comparisons with unidimensional two-factor (need satisfaction and frustration) or three-factor (autonomy, relatedness, and competence) models (Campbell et al., 2017; Chen et al., 2015; Cordeiro et al., 2016a, 2016b; Frielink, Schuengel, & Embregts, 2017; Krijgsman et al., 2017; Longo et al., 2016; Neubauer & Voss, 2016, 2017; Nishimura & Suzuki, 2016; Rocchi, Pelletier, Cheung, Baxter, & Beaudry, 2017).

However, observing the superiority of a six-factor model relative to a one-, two- or three-factor models do not exclude the possibility that more global need satisfaction and/or frustration factors may co-exist with the more specific constructs of autonomy, relatedness, and competence satisfaction and frustration. Some studies have also considered this possibility through the reliance on higher-order factor models, or models inspired by the multitrait-multimethod tradition (Cordeiro et al., 2016a, 2016b; Longo et al., 2016; Nishimura & Suzuki, 2016; Sheldon & Hilpert, 2012). Generally, studies have tended to reject higher-order representations where the six a priori factors were themselves used to assess higher-order factors representing need satisfaction and frustration (Cordeiro et al., 2016a; Nishimura & Suzuki, 2016), although such representations were still sometimes retained to support the use of a more parsimonious set of two composite scores reflecting need satisfaction and frustration (e.g., Campbell et al., 2017; Costa, Ntoumanis, & Bartholomew, 2015; Krijgsman et al., 2017). Similarly, results generally showed that relying on multitrait-multimethod operationalization involving the simultaneous estimation of correlated need factors (competence, autonomy, and relatedness) with correlated method factors (reflecting need satisfaction and frustration) did not bring much to the representation of the data (Cordeiro et al., 2016a, 2016b; Neubauer & Voss, 2016, 2017; Sheldon & Hilpert, 2012). However, as we will see below, these two alternative types of models are themselves flawed when one seeks to represent the presence of construct-relevant psychometric multidimensionality. In fact, as noted by Brunet, Gunnel, Teixeira, Sabiston, and Bélanger (2016), prior research has sought to identify whether we should be looking at the "forest" (i.e., a global measure of need satisfaction/frustration) *or* the "trees" (i.e., specific measures of autonomy, relatedness, and competence need satisfaction and/or frustration), rather than to find ways to look at both simultaneously in order to "have your cake and eat it too".

**Psychometric Multidimensionality and the Bifactor-ESEM Framework**

In a recent contribution focusing specifically on the investigation of psychometric multidimensionality, Morin, Arens et al. (2016a, p. 117) noted that CFA "fail to account for at least two sources of construct-relevant psychometric multidimensionality, and might thus produce biased parameter estimates as a result of this limitation" (see also Morin, Arens, Tran, & Caci, 2016b; Morin, Boudrias et al., 2016, 2017). More precisely, construct-relevant psychometric multidimensionality refers to test indicators presenting true score associations with more than one latent construct. As such, this form of psychometric multidimensionality does not refer to random measurement error, but to the fact that some indicators naturally tap into more than one construct.

**Conceptually-Related Constructs.** The first of these sources, which has so far been neglected in priori studies of need satisfaction and frustration, pertains to the assessment of conceptually-related constructs. Given the naturally fallible nature of the indicators that are typically used in psychological research, which are rarely pure indicators of a single subscale, at least some degree of construct-relevant associations can be expected between items and non-target conceptually-related constructs. However, in CFA, each indicator is explicitly forced to be associated with a single construct, an assumption that can easily be relaxed through the reliance on classical exploratory factor analyses (EFA) incorporating cross-loadings between items and non-target constructs. In a recent review of statistical simulation studies, Asparouhov, Muthén, and Morin (2015) note that whenever cross-loadings (even as small as .100) exist in the population model, relying on CFA model specifications results in inflated estimates of the factor correlations. Alternatively, these same studies show that relying on EFA model-specifications when no cross-loadings are present in the population model still results in unbiased estimates of factor correlations. Given that the true underlying meaning of any psychological constructs lies in the way it relates to other constructs, it seems that relying on CFA may lead to construct misspecification due to the inflation of factor correlations. Interestingly, EFA measurement models have now been incorporated with CFA and structural equation modeling (SEM) into the more generic exploratory structural equation modeling (ESEM) framework (Marsh, Morin, Parker, & Kaur, 2014; Morin, Marsh, & Nagengast, 2013). The development of target rotation even makes it possible to rely on a fully "confirmatory" approach when estimating ESEM factors, allowing for the specification of target loadings in a confirmatory manner while cross-loadings are "targeted" to be as close to zero as possible while still being freely estimated (Asparouhov & Muthén, 2009; Browne, 2001). The value of ESEM for SDT research has been previously demonstrated in relation to the assessment of academic (e.g., Guay, Morin, Litalien, Valois, & Vallerand, 2015; Litalien et al., 2015, 2017), work (e.g., Howard, Gagné, Morin, & Forest, 2017) and sport (Gunnel & Gaudreau, 2015) motivation, as well as need satisfaction (Sànchez-Oliva et al., 2017) and frustration (Myers, Martin, Ntoumanis, Celimli, & Bartholomew, 2014). Generally, these studies have showed that relying on ESEM resulted in well-defined psychological constructs, while helping to deflate the factor correlations (i.e., reduce multicollinearity) among subscales.

**Global and Specific Constructs.** The second source of construct-relevant psychometric dimensionality is related to the above discussion about the forest and the trees, and pertains to the co-existence of global (global need satisfaction and/or frustration) and specific constructs (autonomy, competence, relatedness) assessed from the same set of items. This source of multidimensionality calls for the application of bifactor modeling (Reise, 2012; Rodriguez, Reise, & Haviland, 2016) in which items are allowed to define one global G-factor (e.g., global need satisfaction/frustration) and one specific S-factor (e.g., autonomy, competence and relatedness). In true bifactor models, the S-factors are specified as orthogonal to one another and in relation the G-factors (e.g., Gignac, 2016; Morin, Arens et al., 2016a, 2016b; Reise, 2012), although the G-factors themselves can be correlated with one another when more than one is included in the model (e.g., Caci, Morin, & Tran, 2015). This specification allows for the total item covariance matrix to be directly separated into a global component (i.e., the G-factor) aiming to explain the variance shared among responses to all items, and specific components (i.e., the S-factors) aiming to explain the covariane associated with item subsets that is not already explained by the G-factor. Previous research has demonstrated the value of a bifactor representation of measures of motivation (Gunnel & Gaudreau, 2015; Howard et al., 2017; Litalien et al., 2017), need satisfaction (Brunet et al., 2016; Sànchez-Oliva et al., 2017), and need frustration (Myers et al., 2014), although such an approach has never been applied to a combined measure of need satisfaction and frustration. Bifactor studies of need satisfaction measures generally supported the added-value of simultaneously considering co-existing global and specific cosntructs in terms of prediction (Brunet et al., 2016; Sànchez-Oliva et al., 2017). More precisely, these studies revealed that the key construct responsible for associations between need satisfaction and a variety of outcome measures was the G-factor. However, these studies also identified associations involving the S-factors, reflecting the specific nature of each need over and above global levels of need satisfaction.

**An Integrated Approach.** The bifactor-ESEM framework provides a way to simultaneously consider these two sources of construct-relevant multidimensionality in a confirmatory manner when it relies on the newly developed orthogonal bifactor target rotation (Reise, 2012). Morin and colleagues (Morin, Arens et al., 2016a, 2016b; Morin, Boudrias et al., 2016, 2017) note that the ability to rely on this combined framework is particularly important given the ease with which each alternative model is able to absorb unmodelled sources of construct-relevant psychometric multidimensionality (Asparouhov et al., 2015; Morin, Arens et al., 2016a; Murray, & Johnson, 2013): (a) unmodelled cross-loadings lead to inflated factor correlations in CFA, or inflated G-factor loadings in bifactor-CFA; (b) an unmodelled G-factor leads to inflated factor correlations in CFA, or inflated cross-loadings in ESEM. Given the aforementioned results, it is perhaps not so surprising to note that the few prior studies that have applied this bifactor-ESEM framework to measures of need satisfaction (Sànchez-Oliva et al., 2017) or frustration (Myers et al., 2014) have supported the added-value of this representation over that of alternative CFA, ESEM, and bifactor-CFA models.

**A Single Continuum or two Global Dimensions?** A particular challenge faced by research focusing on a combined measure of need satisfaction and frustration is to determine whether one (representing a global continuum of need fulfillment characterized by negative factor loadings for need frustration items and positive factor loadings for need satisfaction items) or two (representing separate global dimensions of need satisfaction and frustration) overarching dimensions could be identified. Indeed, the recognition that a lack of satisfaction (or dissatisfaction) is inherently distinct from frustration (Costa et al., 2015; Vansteenkiste & Ryan, 2013) suggests that a complete representation of need fulfillment needs to rely on indicators directly tapping into both need satisfaction and frustration. However, this recognition does not mean that both facets (satisfaction and frustration) of need fulfillment necessarily form two distinct dimensions. To our knowledge, this important distinction has never been formally tested in SDT research, which rather appears to rely on the implicit assumption that both facets do indeed form distinct dimensions – thus neglecting the fact that correlations among these facets are sometimes as high as -.60 or -.70 (e.g., Campbell et al., 2016; Chen et al., 2015; Cordeiro et al., 2016a). A key objective of the present study is to test this assumption. Similar questions are permeating research on psychological health. Indeed, the recognition that health goes beyond the lack of ill-being to also encompass the presence of wellbeing has often been taken to suggest that wellbeing and ill-being form distinct dimensions rather than opposite poles of the same continuum. Using bifactor-ESEM, a recent study (Morin, Boudrias et al., 2016) supported the continuum hypothesis, showing that global psychological health was best represented by a single G-factor (i.e., solutions involving two G-factors did not result in model fit improvement, and resulted in highly correlated factors). Interestingly, in a recent daily diary study, Bidee, Vantilborgh, Pepermans, Griep and Hofmans (2016) observed that the temporal dynamics of need satisfaction and frustration tended to mirror one another, suggesting a single underlying continuum.

**Unsuitable Alternatives.** Before moving forward, we previously noted that some studies have attempted to tackle the second source of construct-relevant multidimensionality (i.e., global/specific) using higher-order (e.g., Cordeiro et al., 2016a; Nishimura & Suzuki, 2016) or multitrait-multimethod models (e.g., Cordeiro et al., 2016a, 2016b; Neubauer & Voss, 2016, 2017), and generally failed to support the added-value of these alternative representations of the data. To understand the failure of these models and the possible superiority of a bifactor representation, one needs to look more closely at some of the technical characteristics of these alternative models.

***Hierarchical Models.*** In hierarchical models, each indicator is associated with a first-order factor (e.g., autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration), and these first-order factors are specified as loading on one (e.g., need fulfillment) or more (e.g., need satisfaction and frustration) higher-order factors. Although elegant at first sight, this operationalization relies on one extremely stringent assumption that is almost never empirically verified (Gignac, 2016). Indeed, higher-order models assume that (a) the associations between the indicators and the higher-order factor(s) are indirect (i.e., mediated by the first-order factors), and that (b) the associations between the indicators and the unique part of the first-order factor are also mediated by the first-order factor. Indirect effects are obtained by the multiplication of two coefficients, corresponding respectively to: (a) the loading on the first-order factor (FO) multiplied by the loading of the first-order factor on the higher-order factor (HO); (b) the loading on the first-order factor (FO) multiplied by the disturbance of the first-order factor (DFO). This reality means that, for all indicators of a single first-order factor, the ratio of variance explained by the global/specific constructs ends up being exactly the same and equal to HO/DFO.

Gignac (2016) and others (e.g., Morin, Arens et al., 2016a; Reise, 2012) argued that this restrictive proportionality constraint explains why higher-order models typically fail to achieve acceptable levels of goodness-of fit, even when comparable bifactor representations are able to provide a satisfactory representation of the data. Based on these observation, the emerging recommendation is that bifactor models should be preferred, unless there are some strong theoretical reasons to assume that the proportionality constraint makes sense in a specific research area. This was not the case in the present study.

***Multitrait-Multimethod Models.*** In multitrait-multimethod models, in contrast to bifactor models, the traits factors (e.g., competence, autonomy, and relatedness) are typically allowed to correlate with one another, the method factors (e.g., satisfaction and frustration) are also typically allowed to correlate with one another, but the trait factors are not allowed to correlate with the method factors. In contrast, bifactor models are specified as orthogonal, although models including more than one G-factor typically allow these G-factors to correlate with one another. So, the key difference lies in the presence of factor correlations among the method factors, but not among the S-factors. This difference is subtle, but may have major implications for the results, and explains why multitrait-multimethod models are typically used to control for some source of construct-irrelevant multidimensionality (e.g., some source of extraneous influence on item ratings that needs to be controlled for in the model, such as informant effects or wording effects) (e.g., Eid, 2000; Eid et al., 2008), whereas bifactor models are typically used to estimate G- and S- factor that are all assumed to be substantively meaningful. As such, multitrait-multimethod models are not relevant to the study of construct-relevant psychometric multidimensionality that is the object of the present study.

In a bifactor model, the clean partitioning of the variance explained by the global and specific constructs is made possible by the orthogonality of the factors, as this orthogonality forces the covariance shared among all items to be fully absorbed into the G-factor, while the S-factors represent the covariance shared among a subset of items but not with the others. As such, taking out one of the S-factors from a bifactor model would not change the meaning of the G-factor (Arens & Morin, 2017; Morin, Myers, & Lee, 2017). In contrast, multitrait-multimethod models "force" all construct-relevant variance to be absorbed in the trait factor, and relies on the method factors only to provide an explicit estimate of the extent to which ratings provided by various methods differ from one another. However, models in which all items are associated with a method factor, and in which all method factors are allowed to correlate with one another frequently fail to converge on a proper solution. This observation led Eid (2000; Eid et al., 2008) to propose the correlated trait correlated method minus 1 model, or CT-C(M-1), in which one of the method factor is taken out, which has the effect of "anchoring" the trait factor into the omitted method factor, resulting in the estimation of method factors reflecting the specificity of the remaining methods. This phenomenon is directly related to the non-orthogonality of the method factors, which have the effects of "pushing" into the trait factor not only the information that is shared among all items, but also the information that is shared among the items associated with the referent (omitted) method. This characteristic also results in the estimation of method factors reflecting differences between these methods and the referent method.

**The Present Investigation**

The objective of the present research is to investigate the underlying dimensionality of a measure of satisfaction and frustration of the basic psychological needs for autonomy, relatedness, and competence using the bifactor-ESEM framework. To achieve this objective, several alternative measurement models will first be contrasted using a large community sample of adults. To more specifically assess the generalizability of these results to all Hungarian adults, we then verify the extent to which they can be replicated on a second sample, recruited so as to be representative of the adult Hungarian population.

In addition, tests of measurement invariance as a function of participants' gender and of differential item functioning (DIF) as a function of their age were conducted in order to verify the extent to which our results could be expected to generalize as a function of meaningful individual characteristics (e.g., Millsap, 2011; Morin et al., 2013). Indeed, it is critical to investigations, such as this one, aiming to provide an improved psychometric representation of latent constructs to be able to demonstrate that the new representation generalizes not only to similar samples of participants, but also as a function of naturally-occurring participant characteristics.

Still, gender and age were not only selected for convenience purposes. A recent meta-analysis of 42 studies of basic psychological needs conducted among samples of working adults (Van den Broeck et al., 2016) showed women tend to present significantly higher levels of satisfaction of their need for relatedness relative to men, which is aligned with the fact that women generally tend to value social relationships more than men (Cross & Madson, 1997; Helgeson, 1994; Hyde, 2014). No differences were observed as a function of gender in regards to the satisfaction of the needs for autonomy and competence. However, among the few studies which simultaneously considered need satisfaction and frustration, Haerens, Aelterman, Vansteenkiste, Soenens, and Van Petegem (2015) noted that adolescent boys tended to report higher levels of global need satisfaction than girls, and equivalent levels of need frustration. In terms of age, despite the fact that SDT is an explicitly developmental theory (Deci & Ryan, 1985, 2000; also see Ryan, 2005), surprisingly little research has considered possible age-related differences in levels of need satisfaction and frustration. Among the few exceptions, Chen et al. (2015) reported positive correlations between age and university students' levels of autonomy and competence need satisfaction, and negative correlations between age and levels of autonomy and competence need frustration. Still, indirect evidence coming from research on personality and self-concepts suggest that, across the lifespan, age seems to be accompanied by greater levels of maturity, self-esteem, selfacceptance, agreeability, emotional stability and psychopathology, alluding to perhaps greater levels of need satisfaction, although the observed relations are seldom linear (e.g., ESEMeD/MHEDEA-2000 Investigators, 2004; Kessler et al., 2007; Marsh, Martin, & Jackson, 2010; Marsh, Nagengast, & Morin, 2013).

However, to conclude with confidence that observed gender or age-related differences are meaningful, it is critical to first establish the measurement invariance (or lack of DIF) of the instrument as a function of these characteristics (Millsap, 2011; Morin et al., 2013). Interestingly, the few previous studies in which the measurement invariance or DIF of need satisfaction/frustration measures was tested as a function of age or gender have supported the invariance of these measures (e.g., Cordeiro et al., 2016a; Vlachopoulos, 2008; Wilson, Rogers, Rodgers, & Wild, 2006).

# Methods

## Participants and Procedures.

**Study 1.** The first study relied on a community sample of 2301 Hungarian adults (1520 female, 66.1%) who were aged between 18 and 71 (*M* = 25.25; *SD* = 6.99). These participants reported their highest level of education as primary (7.7%), secondary (70.1%) and higher (22.1%), their place of residence as the capital city (39.5%), county capitals (14.8%), cities (29.9%) and country (15.9%), and their employment status as full-time (26.4%), part-time (15.9%), occasional (17.8%) and unemployed (39.9%). Participants were recruited through various online forums, websites and mailing lists, and completed online questionnaires. Participants were first informed about the aim of the study. If they wished to participate, they had to check a box; otherwise, they were excluded. This study was conducted in accordance with the Declaration of Helsinki and with the approval of the University Research Ethics Committee.

**Study 2.** The second study relied on a nationally representative sample of 504 Hungarian adults who use Internet at least once a week. This sample was recruited with the help of a research market company in May 2017 using a multiple-step, proportionally stratified, probabilistic sampling method and was nationally representative in terms of gender (51.8% female), age (18 to 60 years; *M* = 39.59 years; *SD* = 12.03 years), education (19.8%: primary; 58.3%: secondary; 21.8%: higher) and place of residence (20.2%: capital city; 19.6%: county capitals; 31.9%: cities; 28.2%: country). Participants reported their employment status as full-time (59.7%), part-time (8.9%), occasional (5.6%) and unemployed (25.8%), and completed the same online questionnaires, following the same procedures as in Study 1.

**Measures.** The BPNSFS (Chen et al., 2015) was used to measure individuals' need satisfaction and frustration. The BPNSFS is a 24-item measure with six 4-items factors covering autonomy satisfaction (e.g., "I feel a sense of choice and freedom in the things I undertake") and frustration (e.g., "I feel forced to do many things I wouldn't choose to do"), relatedness satisfaction (e.g., "I feel that the people I care about also care about me") and frustration (e.g., "I feel excluded from the group I want to belong to"), as well as competence satisfaction (e.g., "I feel confident that I can do things well") and frustration (e.g., "I feel insecure about my abilities"). All items are rated on a five-point agreement scale ranging from 1 = not true at all for me to 5 = very true for me. A standardized back-translation procedure (Beaton, Bombardier, Guillemin, & Ferraz, 2000; Hambleton & Kanjee, 1995) was followed to obtain the Hungarian version of the BPNSFS. The original English items were first translated into Hungarian separately by two bilingual experts, and translation discrepancies were discussed among the research team and translators to obtain an initial Hungarian version. Two additional bilingual translators not involved in the first steps then back-translated this initial version into English. The back-translated versions were then compared with one another and with the original version and any inconsistencies were highlighted. These inconsistencies were resolved in committee, and the process was repeated until the versions were identical. The Hungarian version is available in Appendix 1 of the online supplements.

## Statistical Analyses

**Model Estimation.** All analyses were conducted using Mplus 7.4 (Muthén & Muthén, 1998-2015) and estimated using the robust maximum likelihood estimator (MLR) which provides standard errors and tests of model fit that are robust to the non-normality of the data and to the reliance on a five-point Likert rating scales. No missing responses were present given the way the online questionnaire was set-up. In the first stage of the analyses, a series of alternative CFA and ESEM models were assessed using the first study sample: (a) one factor CFA (Model 1) model (global need fulfillment); (b) two-factors CFA (Model 2) and ESEM (Model 3) models (global need satisfaction and frustration); (c) three-factors CFA (Model 4) and ESEM (Model 5) models (global fulfillment of the needs for autonomy, relatedness, and competence); (d) six-factors CFA (Model 6) and ESEM (Model 7) models (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration). Then, bifactor counterparts were also estimated: (a) bifactor-CFA (Model 8) and ESEM (Model 9) models including two S-factors (need satisfaction and frustration) and 1 G-factor (global need fulfillment); (b) bifactor-CFA (Model 10) and ESEM (Model 11) models including three S-factors (autonomy, competence and relatedness) and 1 G-factors (global need fulfillment); (c) bifactor-CFA (Model 12) and ESEM (Model 13) models including three S-factors (autonomy, competence and relatedness) and 2 correlated G-factors (global need satisfaction and frustration); (d) bifactor-CFA (Model 14) and ESEM (Model 15) models including six S-factors (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) and 1 G-factors (global need fulfillment); (e) bifactor-CFA (Model 16) and ESEM (Model 17) models including six S-factors (autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) and 2 correlated G-factors (global need satisfaction and frustration). In the CFA models, items were only allowed to define their a priori factors, factors were allowed to correlate, and no cross-loadings were estimated. In the ESEM models, the factors were defined as in the CFA models, and all cross-loadings were freely estimated but assigned a target value of zero using an oblique target rotation procedure (Browne, 2001). In bifactor-CFA models, items were allowed to define one a priori S-factor as well as one G-factor, and most factors were specified as orthogonal, although G-factors were allowed to correlate with one another in models including more than one G-factor. Bifactor-ESEM models were specified as their bifactor counterparts, although all cross-loadings involving the S-factors were freely estimated but assigned a target value of zero using an orthogonal bifactor target rotation procedure (Reise, 2012). These same models were then estimated using the second study.

**Measurement Invariance.** The measurement invariance of the most optimal measurement model was then systematically assessed across the samples from the two studies. These tests were conducted in the following sequence (Millsap, 2011; Morin, Arens et al., 2016a 2016b): (1) configural invariance; (2) weak invariance (invariance of the factor loadings/cross-loadings); (3) strong measurement (invariance of the factor loadings/cross-loadings, and intercepts); (4) strict invariance (invariance of the factor loadings/cross-loadings, intercepts, and uniquenesses); (5) latent variance-covariance invariance (invariance of the factor loadings/cross-loadings, intercepts, uniquenesses, and latent variances-covariances); (6) latent means invariance (invariance of the factor loadings/cross-loadings, intercepts, uniquenesses, latent variances-covariances, and latent means). It is important to keep in mind that, whereas the first four steps test for the presence of measurement biases or difference across samples, the last two steps assume some level of measurement invariance (weak for step 5 and strong for step 6) and test for the presence of meaningful group-based differences occurring at the level of the factor variances, covariances, or means. Assuming strong measurement invariance, the two samples were then merged to test the measurement invariance of the most optimal measurement model as a function of gender, following the same aforementioned sequence.

**Differential Item Functioning**. Starting from the most invariant measurement model estimated as a function of participants' gender, tests of DIF were then conducted as a function of participants' age within both gender groups. To avoid a suboptimal categorization of age, tests of DIF were conducted by way of a multiple indicators multiple causes (MIMIC) model (e.g., Morin et al., 2013; Morin, Maïano, et al., 2016). In this MIMIC approach, the need satisfaction/frustration factors are regressed on age (we also included a quadratic function of age – age$^2$–to account for possible non-linearity in these relations), and DIF is identified when direct relations can be observed between the predictors and item responses over and above the effects of the predictors on the factors. To facilitate interpretations, age was standardized prior to the analyses. Three alternative MIMIC models were compared (Morin et al., 2013; Morin, Maïano, et al., 2016): (1) a null effect model in which the paths between age to the items responses and the latent factors are constrained to be zero; (2) a saturated model in which the paths between age and the item responses are freely estimated, but the paths between age and the latent factors are constrained to be zero; and (3) an invariant model in which the paths between age and the item response are constrained to be zero, but the paths between age and the latent factors are freely estimated. The comparison of the null model with the saturated and invariant models verified whether age had an effect on item responses. Then, the comparison of the saturated model with the invariant model tested whether this effect was limited to the latent factors, or indicative of DIF. Starting from the most optimal MIMIC model, a final model was estimated in which the effects of age on the latent factors were constrained to be equal across gender groups.

**Assessment of the Alternative Models.** Because the chi-square ($\chi^2$) test of exact fit tends to be oversensitive to sample size and minor model misspecifications, we relied on the following common goodness-of-fit indices: the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the root mean square error of approximation (RMSEA). According to typical interpretation guidelines (e.g., Hu & Bentler, 1999; Marsh, Hau, & Grayson, 2005; Marsh, Hau, & Wen, 2004), values greater than .90 and .95 for the CFI and TLI are respectively considered to indicate adequate and excellent fit to the data, whereas values smaller than .08 or .06 for the RMSEA respectively support acceptable and excellent model fit. Nested models in measurement invariance tests were compared via consideration of changes ($\Delta$) in goodness-of-fit indices, with decreases CFI and TLI of at least .010 or increases in RMSEA of at least .015 indicates a lack of invariance across groups (Chen, 2007; Cheung & Rensvold, 2002). It is important to keep in mind that goodness-of-fit indices corrected for parsimony (TLI, RMSEA) can improve with the addition of model constraints. Although $\chi^2$ and CFI should be monotonic with complexity, they can still improve with added constraints when the MLR scaling correction factors differ across models. These improvements should be considered to be random.

However, given the aforementioned ability of each alternative (CFA, ESEM, bifactor-CFA, bifactor-ESEM) model to absorb unmodelled sources of construct-relevant psychometric multidimensionality, Morin and colleagues (Morin, Arens et al., 2016a, 2016b; Morin, Boudrias et al., 2016, 2017) note that examination of goodness-of-fit indices is not sufficient, and has to be complemented by a comparison of the parameter estimates and theoretical conformity conducted among all models that manage to achieve an acceptable level of fit to the data. They recommend that this examination should first start by a comparison of CFA and ESEM measurement models in order to verify the need to incorporate cross-loadings. In this comparison, it is important to ascertain that the factors remain well-defined by strong target loadings. However, based on statistical evidence showing that ESEM results in more exact estimates of factor correlations when cross-loadings are present in the population model but unbiased estimates otherwise (Asparouhov et al., 2015), the key comparison involves the factor correlations. The ESEM solution should be favored as long as the observed pattern of factor correlations differs across these two models.

Then, the second comparison should be conducted between the retained ESEM or CFA solution and its bifactor counterpart. At this stage, it is important to keep in mind that the factors (S- and sometimes G-) estimated as part of bifactor models are seldom defined as strongly as those from first-order factor models, which is due to the different way in which the item-level covariance is disaggregated in these models to estimate two sets of factors (G- and S-) rather than a single one (e.g., Reise, 2012; Morin, Arens, & Marsh, 2016a). More precisely, in first-order models, all of the covariance shared among a specific subset of items ends up being absorbed into the first-order factor. In contrast, in bifactor models, all of the covariance that is shared among all items (including the specific subset under consideration) is absorbed into the G-factor, leaving only the covariance present in the target subset of items that is not already explained by the G-factor to be absorbed into the S-factors. As such, the critical component of this second comparison is the observation of a G-factor well-defined by strong factor loadings, accompanied by at least some well-defined S-factors.

## Results

### Study 1: Measurement Structure of the BPNSFS

Goodness-of-fit indices associated with each of the 17 alternative measurement models estimated in Study 1 are reported in the top section of Table 1. Starting with an examination of the alternative first-order CFA and ESEM solutions, it is apparent that only the six-factor solutions were able to achieve an acceptable level of fit to the data. In addition, the goodness-of-fit associated with the ESEM solution (Model 7) appeared to be much higher ($\Delta$CFI = +.038; $\Delta$TLI = +.034; $\Delta$RMSEA = -.015) than that of the CFA solution (Model 6). Comparison of the parameter estimates associated with both of these models, which are reported in Tables S1 and S2 of Appendix 2 in the online supplements, also supports the superiority of the ESEM solution. More precisely, both solutions result in well-defined factors (ESEM: $\lambda$ = .348 to .888, *M* = .583; CFA: $\lambda$ = .433 to .837, *M* = .708). Although the ESEM solution does incorporate multiple statistically significant cross-loadings, none of these cross-loadings is large enough to suggest a problem in terms of factor definition ($|\lambda|$ = .000 to .367, *M* = .078): All cross-loadings are lower than the target loadings and remain under .400. In fact, only two of the estimated cross-loadings are greater than .300, and are related to the satisfaction and frustration of the needs for relatedness (Item 3: "I feel that the people I care about also care about me") and competence (Item 6: "I have serious doubts about whether I can do things well"), suggesting that these items may tap more into a global continuum of need fulfillment than to the more specific satisfaction of frustration of these needs. In addition, the factor correlations are substantially reduced in the ESEM ($|r|$ = .237 to .635, *M* = .408), relative to CFA ($|r|$ = .319 to .835, *M* = .559) solution, and appropriately positive among subscales with the same valence (satisfaction-satisfaction, frustration-frustration) and negative among subscales with a distinct valence (satisfaction-frustration).

The decision was thus made to retain an ESEM representation of the data, a decision that was also supported by an examination of the bifactor alternatives, which also supported the superiority of the bifactor-ESEM, relative to bifactor-CFA, solutions. In fact, with a single exception (Model 12), most of the bifactor-CFA solutions failed to achieve an acceptable level of fit to the data according to at least one of the fit indices, and even Model 12 failed to achieve a level of fit comparable to that of the alternative bifactor-ESEM solutions. So, turning our attention to the bifactor-ESEM solutions, it is interesting to note that many of them are able to achieve an acceptable level of fit to the data, although the solutions including six-S-factors (Models 15 and 17) achieved a level of fit that substantially exceeded that of their counterparts including three S-factors (Model 15 vs. 11: ΔCFI = +.041; ΔTLI = +.057; ΔRMSEA = -.026; Model 17 vs. 13: ΔCFI = +.025; ΔTLI = +.033; ΔRMSEA = -.017). So, the key question that remains is whether the model including two G-factors (reflecting distinct dimensions of need frustration or satisfaction) is able to provide an improved representation of the data relative to the model including a single G-factor (reflecting a global continuum of need fulfilment), given that both models (15 and 17) achieved a similar level of fit to the data. Here, an examination of parameter estimates associated with all models including two G-factors is highly informative. First, when we look at the results of the bifactor-CFA models including two G-factors (Models 12 and 16), we note that the correlation observed between these two G-factors is so high so as to call into question the discriminant validity of these factors (-.718 for Model 12; -.849 for Model 16). Although these correlations are reduced in the bifactor-ESEM solutions (Models 13 and 17), these reveal weakly defined satisfaction ($|\lambda|$ = .007 to .408, *M* = .156) and frustration ($|\lambda|$ = .263 to .510, *M* = .394) factors, arguing against the need to incorporate a second G-factor, and supporting the superiority of Model 15. For interested readers, we also report the detailed parameter estimates from the more complete bifactor-ESEM solution (Model 17) in Table S3 of Appendix 2, in the online supplements.

Examination of the parameter estimates associated with Model 15, which are reported in Table 2, supports this conclusion. These results reveal a well-defined G-factor, reflecting a global underlying continuum of need fulfillment with positive factor loadings associated with the need satisfaction items ($\lambda$ = .432 to .663, *M* = .558) and negative factor loadings associated with the need frustration items ($\lambda$ = -.221 to -.657, *M* = .521). Similarly, with the exception of a few items which mainly reflect the global need fulfillment G-factor rather than their own a priori S-factors (e.g., items 17 and 19), the S-factors also retain at least some degree of meaningful specificity over and above participants' global levels need fulfillment ($\lambda$ = .284 to .685, *M* = .446). As in the ESEM solution, multiple cross-loadings were statistically significant, although of a fully reasonable magnitude ($|\lambda|$ = .000 to .304, *M* = .072). Interestingly, only one of the items (i.e., item 6: "I have serious doubts about whether I can do things well") associated with an ESEM cross-loading greater that .300 still presents a cross-loading greater than .300 (-.304), and again this cross-loading involves the opposite pole (satisfaction vs. frustration) of the same need (competence).

Finally, model-based coefficients of composite reliability proved to be much higher for the G-Factor ($\omega$[1] = .939) than for the S-factors (autonomy satisfaction $\omega$ = .567; relatedness satisfaction $\omega$ = .712; competence satisfaction $\omega$ = .508; autonomy frustration $\omega$ = .619; relatedness frustration $\omega$ = .646; competence frustration $\omega$ = .564), although the later remain generally acceptable when taking into

[1] We report omega coefficients of composite reliability, calculated as (McDonald, 1970):
$\omega = (\Sigma|\lambda_i|)^2 / ([\Sigma|\lambda_i|]^2 + \Sigma\delta_{ii})$ where $\lambda_i$ are the factor loadings and $\delta_{ii}$ the error variances. Compared to classical estimates of scale score reliability (e.g. $\alpha$), $\omega$ has the advantage of taking into account the strength of association between the items and the latent factors ($\lambda_i$), as well as item-specific measurement errors ($\delta_{ii}$) (e.g., Dunn, Baguley, & Brunsden, 2013; Sijtsma, 2009).

account the fact that S-factors generally tend to be weaker in bifactor representations that in first-order models. Furthermore, it is important to keep in mind that these lower levels of reliability would be much more concerning for research relying on scale scores than fully latent variables, given that latent variables are naturally corrected for measurement errors, and thus perfectly reliable.

**Study 2: Replicating the Measurement Structure of the BPNSFS**

Goodness-of-fit indices associated with each of the 17 alternative measurement models estimated in Study 2 are reported in the bottom of Table 1. Examination of these results, as well as of the parameter estimates associated with these different models (available upon request from the first author), support the conclusions from Study 1 regarding the superiority of the bifactor-ESEM solution including six S-factors and one G-factor (Model 15). To more precisely assess the extent to which the retain Model 15 parameter estimates could be replicated across the samples used in the two studies, this model was retained for tests of measurement invariance. The results from these tests are reported in the top section of Table 3. These results revealed that the configural model achieved a satisfactory level of fit to the data, and supported the weak measurement invariance of the model across samples (ΔCFI/TLI ≤ .010; ΔRMSEA ≤ .015). However, the strong invariance of the model was not supported (ΔCFI = -.009; ΔTLI = -.012; ΔRMSEA = +.007), leading to the estimation of a model of partial strong invariance involving the relaxation of equality constraints on the intercept associated with a single item (item 24). The identification of this non-invariant item was realized via an examination of the modification indices associated with the model of strong invariance, coupled with an inspection of the differences across groups in the parameter estimates associated with the model of weak invariance. This model of partial strong invariance was supported by the data, as well as the remaining models of strict, latent-variance-covariance, and latent means invariance (ΔCFI/TLI ≤ .010; ΔRMSEA ≤ .015). Overall, these results confirm that the model was well-replicated across samples.

**Combined Sample: Tests of Gender and Age Effects**

Since the complete measurement invariance (weak, partial strong, strict, variance-covariance, means) of the retained bifactor-ESEM model was supported across samples, the two samples were combined in order to maximize the sample size and statistical power available for analyses of gender and age effects[2]. As a first step, we applied the same sequence of measurement invariance tests to the examination of gender differences in responses to the BPNSFS. The results from these tests are reported in the middle of Table 3, and supported the complete measurement invariance of the model across gender (ΔCFI/TLI ≤ .010; ΔRMSEA ≤ .015). Still, because mean-level differences across gender were of substantive interest, and because prior statistical research has shown that typically used guidelines may not be stringent enough for tests of latent mean differences (Fan & Sivo, 2009), we decided to interpret mean differences obtained from the previous model in the sequence. In multi-group models, all latent means (G-factor, and S-factors) are constrained to be zero in a referent group (i.e., males) for identification purposes, and freely estimated in the other groups (i.e., females; Morin et al., 2013). These freely estimated latent means on the G-factor and the S-factors) provide a direct estimation of the magnitude of the group-differences, expressed in SD units, and are accompanied by tests of statistical significance. When males' latent means were constrained to be zero, females' latent means proved to be higher on the relatedness satisfaction S-factor (.521 SD; $p \leq .01$), lower on the competence satisfaction S-factor (-.207 SD, $p \leq .01$), and not significantly different for the remaining factors ($p \geq .05$).

Finally, starting from the most invariant model from the previous sequence, we incorporated age and age$^2$ as predictors in the resulting MIMIC multiple group model to test for the presence of DIF and mean differences related to participants' age. The results from these analyses are reported in the bottom of Table 3. These results first show that the null model resulted in an acceptable level of fit to the data, but that the saturated model resulted in an substantial improvement in model fit relative to the null model (ΔCFI=+.020; ΔTLI= +.019; ΔRMSEA = -.008), indicating that age has an effect on responses to the BPNSFS. However, the invariant model resulted in a level of fit that was equivalent to that of the saturated model (ΔCFI/TLI ≤ .010; ΔRMSEA ≤ .015), suggesting that the effects of age were limited to scores on the factors, and the absence of DIF. Constraining these paths to equality across gender resulted in a negligible decrease in model fit (ΔCFI/TLI ≤ .010; ΔRMSEA ≤ .015), supporting

[2] Given that partial measurement invariance is sufficient to support comparisons of results across groups (Byrne, Shavelson, & Muthén, 1989; Steenkamp & Bamgartner, 1998), and the similar gender and age composition of the samples being combined, all items including item 24 were retained for these analyses.

the idea that age effects are equivalent for males and females. The parameter estimates concerning the effects of age and age$^2$ on the BPNSFS factors are reported in Table 4 and illustrated in Figure 1. These results show that age has no significant associations with global levels of need fulfillment, relatedness satisfaction and frustration, and autonomy satisfaction. However, autonomy frustration tended to linearly decrease with age, although this decrease remained small in magnitude. More strikingly, competence satisfaction and frustration presented marked, and opposite, curvilinear tendencies as a function of age. More precisely, competence satisfaction increased sharply as a function of age for the younger participants, a tendency that became less pronounced as age increased and flattened-out for older participants. In contrast, competence frustration showed an initially sharp decrease as a function of age (although far less pronounced than the increases in competence satisfaction) that also flattened-out for older participants.

## Discussion

The present series of two studies was anchored into a substantive-methodological synergy framework (Marsh & Hau, 2007). Substantively, this research aimed to better understand the underlying structure of need fulfillment by examining whether the satisfaction and frustration of the three basic psychological needs seen as critical by SDT (i.e., autonomy, relatedness, competence) could be considered to represent two distinct components of psychological functioning, or whether they would be best represented as opposite poles on the same continuum. Methodologically, this study demonstrated the use of the newly developed bifactor-ESEM framework (Morin, Arens et al., 2016a, 2016b) as a valuable tool for the examination of the underlying structure of complex multidimensional instruments, which could easily be transposed to the examination of similar constructs assumed to follow an underlying continuum structure such as psychological health and wellbeing (Morin, Boudrias et al., 2016, 2017), self-concept (Morin, Arens et al., 2016a), human motivation (Howard et al., 2017; Litalien et al., 2017), or even morningness (Morin, Arens et al., 2016b). Across two studies, our results showed that the bifactor-ESEM framework was able to properly disentangle the two sources of construct-relevant multidimensionality present in participants' BPNSFS ratings, resulting in the estimation of a global overarching need fulfillment continuum factor, as well as more specific need satisfaction and frustration factors. In addition to their generalizability across samples, our results also generalized across gender, and did not present any evidence of DIF as a function of age. However, meaningful mean-levels differences were observed as a function of participants' gender and age. We address in turn each of these results and their implications.

### Need Fulfillment as a Single Continuum Rather than Two Distinct Dimensions

A key contribution of the present research relates to the identification of an improved representation of the underlying dimensionality of psychological need fulfillment. So far, SDT has underscored the importance of relying on a systematic assessment of the degree to which basic psychological needs were satisfied or frustrated for specific individuals (Costa et al., 2015; Vansteenkiste & Ryan, 2013). However, the key question of whether considering this valence component should result in the assessment of distinct, yet correlated, dimensions of need satisfaction and frustration, or in the assessment of a single underlying continuum of need fulfillment had not been previously addressed either theoretically or empirically. So far, research rather seems to have implicitly assumed that need satisfaction and frustration would reflect distinct dimensions, without systematically testing this assumption (e.g., Cordeiro et al., 2016a; Nishimura & Suzuki, 2016).

To our knowledge, this research is the first to empirically test this assumption. More precisely, the present study tested this assumption while relying on the overarching bifactor-ESEM framework. This framework is designed to identify, and accurately disaggregate, two sources of construct-relevant psychometric multidimensionality related to the assessment of conceptually-related (via the incorporation of cross-loadings made possible through ESEM) and co-existing global/specific constructs (via the simultaneous assessment of global and specific factors via bifactor modeling) constructs which are already known to be present in ratings of psychological needs satisfaction (e.g., Brunet et al., 2016; Sànchez-Oliva et al., 2017) and frustration (e.g., Myers et al., 2014). Across two distinct samples of participants, our results supported the presence of both sources of construct relevant psychometric multidimensionality in participants' BPNSFS ratings, revealed that six distinct specific factors (reflecting autonomy satisfaction and frustration, competence satisfaction and frustration, and relatedness satisfaction and frustration) were required to accurately reflect these ratings, and demonstrated that these six specific factors co-existed with a single overarching global factor reflecting a global continuum of need fulfilment.

It is important to keep in mind that Morin and colleagues (Morin, Arens et al., 2016a, 2016b; Morin, Boudrias et al., 2016, 2017) proposed the concept of construct-relevant psychometric multidimensionality in order to reinforce the substantive relevance of these two components (i.e., cross-loadings, and G/S-Factors). It is relatively simple to make sense of the G-factor, which was found here to reflect the extent to which participants felt that their basic psychological needs were fulfilled in their lives, and found to reflect a single overarching continuum. However, it is not as straightforward to make sense of the cross-loadings that are required to represent construct-relevant psychometric multidimensionality related to the assessment of conceptually-related constructs. Asparouhov et al. (2015) noted that latent constructs are defined by the way they relate to other constructs – a principle that forms the core of analyses of validity advocated by classical test theory as being central to ascertaining the true meaning of psychological constructs. When considering this, and that the incorporation of cross-loadings results in more exact estimates of factor correlations (e.g., Asparouhov et al., 2015), it becomes obvious that cross-loadings do not necessarily have a meaning in and of themselves, but rather are meaningful through their ability in providing more accurate estimate of the latent constructs themselves. Cross-loadings simply suggest that some items simultaneously tap into the satisfaction of more than one basic need, albeit at different levels. This is consistent with the idea that autonomy may help individuals to maintain strong relationships or to express their competencies, just like having strong relationships or competencies may help one to achieve greater levels of autonomy. However, these cross-loadings do not need to be interpreted in and of themselves, that is as long as they remain small enough in magnitude (as is the case in the present study) so as not to call into question the definition of the constructs themselves (Morin, Arens et al., 2016a, 2016b; Morin, Boudrias et al., 2016, 2017). Obviously, the observation of large cross-loadings should lead to more thorough examinations of the underlying measurement model, and possibly to item deletion.

At a more practical level, the bifactor-ESEM framework provides a way to assess need fulfillment using a model that is able to provide a natural disaggeregation of the effects attributable to global need fulfillment relative to the more specific satisfaction and frustration of the basic needs for autonomy, relatedness and competence. As such, and based on our results, we advocate further SDT research to incorporate bifactor-ESEM measurement models when studying need fulfillment. Still, providing evidence of the superiority of a bifactor-ESEM model is only a first step, and will need to be complemented by additional developments and changes in practices. For research purposes, this observation reinforces prior calls for an increased focus on latent variable models (Marsh & Hau, 2007), which provide a way to assess relations among more accurately defined constructs corrected for measurement error. Importantly, the estimation of such models has been found to be far less demanding than what was initially believed in terms of sample size (e.g., de Winter et al., 2009). Alternatively, complex models could be built in sequence, so that final predictive models could be based on factor scores saved from preliminary measurement models. These factors scores help preserve the underlying nature of the latent constructs, while also incorporating some correction for measurement errors (e.g., Morin, Boudrias et al., 2016, 2017).

**Gender and Age Differences in Need Fulfillment**

Attesting to the generalizability of the previously discussed results, it is important to reinforce that these results were found to generalize (i.e., measurement invariance) to two distinct samples of participants, as well as to male and female participants, and not to be tainted by DIF as a function of participants' age. In addition, these results revealed meaningful gender- and age-related differences on the BPNSFS latent factors, and also found that the effects of age on the BPNSFS factors generalized to male and female participants. Interestingly, observed gender-based differences were well-aligned with our expectations (e.g., Cross & Madson, 1997; Helgeson, 1994; Hyde, 2014; Van den Broeck et al., 2016), and revealed that females tended to present higher levels of relatedness satisfaction. It is also interesting to note that females did not show higher levels of competence frustration relative to males, which could possibly be attributed to the fact that females are nowadays encouraged to study and work, so that they now have greater opportunities to choose between career opportunities (OECD, 2014). However, females were also found to present lower levels of competence satisfaction relative to males. A possible explanation for this unexpected result could be related to glass ceiling effects, which still impedes the professional progression of adult females in their workplaces regardless of their qualifications, efforts and achievements (e.g., Cotter, Hermsen, Ovadia, & Vanneman, 2001). This glass ceiling effect is also associated with a well-documented gap in pay equity (e.g., World Economic Forum, 2016; OECD, 2017), which may also contribute to limit the amount of competence satisfaction experiences by female workers relative to their male counterparts.

Age-related differences presented a slightly more complex pattern. Indeed, whereas global levels of need fulfillment presented no significant relation with age, the results revealed significant associations between autonomy frustration, competence satisfaction and competence frustration. Interestingly, levels of autonomy frustration exhibited a small, yet linear, decrease as a function of age. This result is consistent with the idea that as people get older, they tend to evolve in environments providing them with fewer barriers to the expression of their needs for autonomy, either through the selection or modification of these environments. This result is similar to the La Dolce Vita effect from the field of personality psychology (Marsh et al., 2013) which states that with age, people become more content with themselves and tend to embrace a more accepting attitude towards life. As people become older, they have less obligations towards their social environment (i.e., work, family), which in turn could lead to a decrease in feelings of external pressures related to "having to do something against their will" that is the definition of autonomy frustration.

Additionally, competence satisfaction and frustration present significant, and opposite, curvilinear associations with age. More precisely, competence satisfaction increased sharply as a function of age for the younger participants, a tendency that became less pronounced as age increased and flattened-out for older participants; whereas the opposite relation was observed for competence frustration. The well-documented maturity principle (Caspi, Roberts, & Shiner, 2005) is aligned with this result, suggesting that as people get older, they tend to become more valued and productive contributors to society. However, this productive contribution can only be achieved by the ability to express, and develop, ones' competencies without facing excessive hurdles along the way. Still, in accordance with the La Dolce Vita hypothesis, these increases in the levels of competence satisfaction and matched decreases in competence frustration appear to level off at older ages, when productivity cease to be an issue (Marsh et al., 2013). Similarly, it must be acknowledged that due to the decline in various cognitive functions (Ren, Wu, Chan, & Yan, 2013), learning new skills may become more difficult at older ages (Janacsek, Fiser, & Németh, 2012), which may also explain the levelling off of these tendencies that was observed in the present study. Fortunately, aging is also known to be associated with greater abilities to compensate for losses in important life domains (Brandstädter & Greve, 1994), suggesting that further studies would be needed to more thoroughly explore the mechanisms at play in the age effects observed in the present research.

**Limitations and Directions for Future Research**

Despite its strengths, this research has limitations. For instance, the study only relied on a self-reported cross-sectional measure of need satisfaction and frustration, making it difficult to clearly identify the mechanisms at play in the gender and age effects. In addition, these findings remain cross-sectional, making it impossible to test age-related effects in a developmental manner. As such, the effects of age identified in the present research remain confounded by the generation or birth-cohorts effects which may also explain effects suggestive of differential levels of women emancipation need fulfillment. Furthermore, although our goal was to provide an improved representation of the BPNSFS that could, in theory, be generalized to any culture, the present research focused on samples of Hungarian adults. This limitation is somewhat offset by the demonstration that our results replicated across samples, gender groups, and present no DIF as a function of age. Still, the next step would be to test the generalizability of our results to more diverse linguistic, cultural, and developmental contexts. Similarly, despite the fact that the present results provide strong psychometric evidence in support of the Hungarian version of the BPNSFS, additional studies would be needed to better document its criterion-related validity and temporal stability. In particular, tests of criterion-related validity would be particularly helpful in achieving a more precise definition of the meaning of the various subscales from this instrument once participants' global levels of need fulfillment are taken into account (i.e. the S- versus G-factors). Furthermore, despite the fact that the statistical approach used here to assess the relation between the age, gender, and the BPNSFS factors was naturally controlled for unreliability, the reliability of some of the S-factors remained minimal ($\omega$ = .508 to .712). Thus, future research would do well to also rely on latent variable models, such as those used in the present study, which are also more aligned with the retained bifactor-ESEM representation of the data.

As noted in the introduction, this study was conducted as a substantive-methodological synergy aiming to illustrate the application of new and evolving methodological approaches to substantively important research questions. In terms of methods, we relied on the newly developed and still evolving ESEM and bifactor-ESEM analyses, and systematically contrasted bifactor-ESEM models including one or two G-factors, which had never been done systematically (but see Morin, Boudrias et al., 2016). As we noted, an important aspect of analyses based on the bifactor-ESEM framework is the fact that goodness-of-fit assessment is not sufficient to efficiently contrast alternative representations of the data (CFA, bifactor-CFA, ESEM, bifactor-ESEM), and needs to be complemented by a detailed examination of the parameter estimates. Similarly, the extent to which typical interpretation guidelines for goodness-of-fit indices apply to ESEM and bifactor-ESEM is currently unknown, and would need to be more thoroughly examined in future statistical research (e.g., Morin, Arens and Marsh, 2016). A recent development in the field of goodness-of-fit assessment needs to be acknowledge here, and should be incorporated in future research looking at the relative performance of various goodness-of-fit indices for the assessment and comparison of complex ESEM and bifactor-ESEM models. Yuan, Chan, Marcoulides, and Bentler (2016; also see Marcoulides & Yuan, 2017) recently developed adjusted goodness-of-fit indices based on an equivalence testing approach rather than on classical null hypothesis testing. Typical goodness-of-fit assessment relies on an approach through which a null hypothesis has to be endorsed for model fit to be supported, which does not necessarily implies that the null hypothesis holds, but simply that it cannot be rejected. In addition, this approach does not allow for a specific control of the size of the model misspecification that is deemed to be acceptable in a specific area of research. In contrast, the new equivalence testing approach focuses on model endorsement based on a priori determined levels of acceptable misspecification. Despite its promise, the efficacy of this approach for model assessment and comparisons remains to be more systematically assessed in future statistical research. Obviously, this research would be further supported by the incorporation of this new approach into a variety of user's friendly statistical packages, as it is for the moment limited to the more technical statistical R package.

## Conclusion

This article investigated the structure of adult ratings of the satisfaction and frustration of the needs for autonomy, competence, and relatedness using the newly developed bifactor-ESEM framework. Our results supported the need to rely on this framework in order to properly represent both sources of construct relevant psychometric multidimensionality present in BPNSFS and related to the assessment of conceptually-related constructs organized around a global overarching continuum of need fulfillment. Similar results have been previously found in SDT-related research focusing on the structure of measures of motivation (Gunnel & Gaudreau, 2015; Howard et al., 2016), need thwarting (Myers et al., 2014) and need satisfaction (Sànchez-Oliva et al., 2017), attesting to the importance of this approach for SDT. In addition, the present research also revealed gender differences alluding to a possible deleterious impact of residual gender-gap inequalities, and age-related differences suggesting improvements in the fulfillment of the needs for autonomy and competence as a function of age. Importantly, bifactor-ESEM provides a way to simultanesouly consider the global fulfillment, and specific satisfaction and frustration, of all three needs into a single model that is not tainted by inflated factor correlations or measurement errors. Finally, this research also proposed a promising Hungarian measure of need fulfillment, thus contributing to the ability to conduct cross-cultural studies.

## References

Arens, A.K., & Morin, A.J.S. (2017). Improved representation of the Self-Perception Profile for Children through bifactor exploratory structural equation modeling. *American Educational Research Journal, 54,* 59-87.

Asparouhov, T., & Muthén, B. (2009). Exploratory structural equation modeling. *Structural Equation Modeling, 16,* 397-438.

Asparouhov, T., Muthén, B., & Morin, A.J.S. (2015). Bayesian Structural equation modeling with cross-loadings and residual covariances: Comments on Stromeyer et al. *Journal of Management, 41,* 1561-1577.

Bartholomew, K.J., Ntoumanis, N., Ryan, R.M., Bosch, J.A., & Thøgersen-Ntoumani, C. (2011). Self-determination theory and diminished functioning: The role of interpersonal control and psychological need thwarting. *Personality and Social Psychology Bulletin, 37,* 1459-1473.

Beaton, D.E., Bombardier, C., Guillemin, F., & Ferraz, M.B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine, 25,* 3186-3191.

Bidee, J., Vantilborgh, T., Pepermans, R., Griep, Y., & Hofmans, J. (2016). Temporal dynamics of need satisfaction and need frustration. Two sides of the same coin?. *European Journal of Work and Organizational Psychology*, *25*, 900-913.

Brandtstädter, J., & Greve, W. (1994). The aging self: Stabilizing and protective processes. *Developmental Review*, *14*, 52-80.

Browne, M. (2001) An overview of analytic rotation in exploratory factor analysis. *Multivariate Behavioral Research*, *36*, 111-150.

Brunet, J., Gunnel, K.E., Teixeira, P., Sabiston, C.M., & Bélanger, M. (2016). Should we be looking at the forest or the trees? Overall psychological need satisfaction and individual needs as predictors of physical activity. *Journal of Sport & Exercise Psychology, 38*, 317-330.

Byrne, B.M., Shavelson, R.J., & Muthén, B.O. (1989). Testing for the equivalence of factor covariance and mean structures: the issue of partial measurement invariance. *Psychological Bulletin*, *105*, 456-466.

Caci, H., Morin, A.J.S., & Tran, A. (2015). Investigation of a bifactor model of the Strengths and Difficulties Questionnaire. *European Child and Adolescent Psychiatry, 24*, *1291-1301*

Campbell, R., Tobback, E., Delesie, L., Vogelaers, D., Mariman, A., & Vansteenkiste, M. (2017). Basic psychological need experiences, fatigue, and sleep in individuals with unexplained chronic fatigue. *Stress & Health*. Early view doi: 10.1002/smi.2751

Campbell, R., Vansteenkiste, M., Delesie, L., Soenens, B., Tobback, E., Vogelaers, D., & Mariman, A. (2016). The role of basic psychological need satisfaction, sleep, and mindfulness in the health-related quality of life of people living with HIV. *Journal of Health Psychology*, Early view doi: 10.1177/1359105316678305.

Caspi, A., Roberts, B. W., & Shiner, R. L. (2005). Personality development: Stability and change. *Annual Review of Psychology, 56*, 453– 484.

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E.L., Van der Kaap-Deeder, J., ... & Ryan, R.M. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, *39*, 216-236.

Chen, F.F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling*, *14*, 464-504.

Cheung, G.W., & Rensvold, R.B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, *9*, 233-255.

Church, A.T., Katigbak, M.S., Locke, K. D., Zhang, H., Shen, J., de Jesús Vargas-Flores, J., ... & Mastor, K.A. (2013). Need satisfaction and well-being: Testing self-determination theory in eight cultures. *Journal of Cross-Cultural Psychology*, *44,* 507-534.

Cotter, D.A., Hermsen, J. M., Ovadia, S., & Vanneman, R. (2001). The glass ceiling effect. *Social Forces, 80*, 655-681.

Cordeiro, P., Paixão, P., Lens, W., Lacante, M., & Luyckx, K. (2016a). The Portuguese Validation of the Basic Psychological Need Satisfaction and Frustration Scale: Concurrent and longitudinal relations to well-being and ill-being. *Psychologica Belgica*, *56*, 193-209.

Cordeiro, P., Paixão, P., Lens, W., Lacante, M., & Sheldon, K.M. (2016b). Factor sturcture and dimensionality of the balanced measure of psychological needs among Portuguese high school students: Relations to well-being and ill-being. *Learning and Individual Differences*, *47,* 51-60.

Costa, S., Ntoumanis, N., & Bartholomew, K.J. (2015). Predicting the brighter and darker sides of interpersonal relationships. *Motivation & Emotion*, *39*, 11-24.

Cross, S., & Madson, L. (1997). Models of the self: Self-construals and gender. *Psychological Bulletin*, *122*, 5-37.

Deci, E.L., & Ryan, R.M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum.

Deci, E.L., & Ryan, R.M. (2000). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*, 227-268.

Deci, E.L., Ryan, R.M., Gagné, M., Leone, D.R., Usunov, J., & Kornazheva, B.P. (2001). Need satisfaction, motivation, and well-being in the work organizations of a former eastern bloc country. *Personality & Social Psychology Bulletin*, *27,* 930-942.

de Winter, J.C.F., Dodou, D., & Wieringa, P.A. (2009). Explorarory factor analysis with mall sample sizes. *Multivariate Behavioral Resrearch*, *44*, 147-181.

Dunn, T., Baguley, T., & Brunsden, V. (2014). From alpha to omega: A practical solution to the pervasive problem of internal consistency. *British Journal of Psychology, 105*, 399-412.

Eid, M. (2000). A multitrait-multimethod model with minimal assumptions. *Psychometrika*, *65*, 241-261.

Eid, M., Nussbeck, F.W., Geiser, C., Cole, D.A., Gollwitzer, M., & Lischetzke, M. (2008). Structural equation modelling of multitrait-multimethod data: Different models for different types of methods. *Psychological Methods, 13*, 230-253.

ESEMeD/MHEDEA 2000 Investigators. (2004). Prevalence of mental disorders in Europe: Results from the European Study of the Epidemiology of Mental Disorders (ESEMeD) project. *Acta Psychiatrica Scandinavica, 109*(Suppl. 420), 21–27.

Fan, X., & Sivo, S.A. (2009). Using goodness-of-fit indexes in assessing mean structure invariance. *Structural Equation Modeling*, *16*, 54–69.

Frielink, N., Schuengel, C., & Embregts, P.J.C.M (2017). Psychometric properties of the basic psychological need satisfaction and frustartion scale – Intellectual disability (BPNSFS-ID). *European Journal of Psychological Assessment*. Early view doi: 10.1027/1015-5759/a000366

Gignac, G.E. (2016). The higher-order model imposes a proportionality constraint: That is why the bifactor model tends to fit better. *Intelligence, 55*, 57–68.

Guay, F., Morin, A.J.S., Litalien, D., Valois, P., & Vallerand, R.J. (2015). Application of exploratory structural equation modeling to evaluate the academic motivation scale. *Journal of Experimental Education, 83*, 51-82.

Gunnel, K.E., & Gaudreau, P. (2015). Testing a bi-factor model to disentangle general and specific motivation in self-determination theory. *Personality & Individual Differences*, *81*, 35–40.

Haerens, L., Aelterman, N., Vansteenkiste, M., Soenens, B., & Van Petegem, S. (2015). Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation. *Psychology of Sport and Exercise, 16*, 26-36.

Hambleton, R., & Kanjee, A. (1995). Increasing the validity of cross-cultural assessments: Improved methods for test adaptations. *European Journal of Psychological Assessment, 11*, 147–157.

Helgeson, V.S. (1994). Relation of agency and communion to well-being: Evidence and potential explanations. *Psychological Bulletin, 116*, 412-428.

Howard, J.L., Gagné, M., Morin, A.J.S., & Forest, J. (2017). Using bifactor exploratory structural equation modeling to test for a continuum structure of motivation. *Journal of Management*. Early view: doi: 10.1177/0149206316645653

Hu, L., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Hyde, J.S. (2014). Gender similarities and differences. *Annual Review of Psychology, 65*, 373-398.

Janacsek, K., Fiser, J., & Nemeth, D. (2012). The best time to acquire new skills: age-related differences in implicit sequence learning across the human lifespan. *Developmental Science*, *15*, 496-505.

Kessler, R.C., Angermeyer, M., Anthony, J., de Graaf, R., Demyttenaere, K., Gasquet, I., . . . Üstün, T. B. (2007). Lifetime prevalence and age-of-onset distributions of mental disorders in the World Health Organization's World Mental Health Survey Initiative. *World Psychiatry, 6*, 168–176.

Krijgsman, C., Vansteenkiste, M., van Tartwijk, J., Maes, J., Borghouts, L., Cardon, G., ... & Haerens, L. (2017). Performance grading and motivational functioning and fear in physical education: A self-determination theory perspective. *Learning and Individual Differences*, *55*, 202-211.

Litalien, D., Guay, F., & Morin, A.J.S. (2015). Motivation for PhD studies: Scale development and validation. *Learning and Individual Differences, 41*, 1-13.

Litalien, D., Morin, A.J.S., Gagné, M., Vallerand, R.J., Losier, G.F., & Ryan, R.M. (2017). Evidence of a continuum structure of academic self-determination: A two-study test using a bifactor-ESEM representation of academic motivation. *Contemporary Educational Psychology*, *51*, 67-82.

Longo, Y., Gunz, A., Curtis, G. J., & Farsides, T. (2016). Measuring need satisfaction and frustration in educational and work contexts: The Need Satisfaction and Frustration Scale (NSFS). *Journal of Happiness Studies*, *17*, 295-317.

Luyckx, K., Vansteenkiste, M., Goossens, L., & Duriez, B. (2009). Basic need satisfaction and identity formation: Bridging self-determination theory and process-oriented identity research. *Journal of Counseling Psychology, 56*, 276-288.

Marsh, H.W., & Hau, K.T. (2007). Applications of latent-variable models in psychology: The need for methodological-substantive synergies. *Contemporary Educational Psychology*, *32*, 151-170.

Marsh, H.W., Hau, K.-T., & Grayson, D. (2005). Goodness of fit evaluation in structural equation modeling. In A. Maydeu-Olivares & J. McArdle (Eds.), *Contemporary psychometrics. A Festschrift for Roderick P. McDonald*. Mahwah, NJ: Erlbaum.

Marsh, H.W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to cutoff values for fit indexes and dangers in overgeneralizing Hu & Bentler's (1999). *Structural Equation Modeling, 11*, 320-341.

Marsh, H.W., Martin, A.J., & Jackson, S. (2010). Introducing a short version of the Physical Self Description Questionnaire: New strategies, short-form evaluative criteria, and applications of factor analyses. *Journal of Sport & Exercise Psychology*, *32*, 438–482.

Marsh, H., Morin, A.J.S., Parker, P., & Kaur, G. (2014). Exploratory structural equation modeling: An integration of the best features of exploratory and confirmatory factor analysis. *Annual Review of Clinical Psychology, 10*, 85-110.

Marsh, H.W., Nagengast, B., & Morin, A.J.S. (2013). Measurement invariance of big-five factors over the life span: ESEM tests of gender, age, plasticity, maturity, and la dolce vita effects. *Developmental psychology*, *49*, 1194-1218.

Marsh, H.W., Scalas, L.F., & Nagengast, B. (2010). Longitudinal tests of competing factor structures for the Rosenberg Self-Esteem Scale: traits, ephemeral artifacts, and stable response styles. *Psychological Assessment*, *22*, 366-381.

McDonald, R.P. (1970). Theoretical foundations of principal factor analysis, canonical factor analysis, and alpha factor analysis. *British Journal of Mathematical & Statistical Psychology*, *23*, 1-21.

Morin, A.J.S., Arens, A., & Marsh, H. (2016a). A bifactor exploratory structural equation modeling framework for the identification of distinct sources of construct-relevant psychometric multidimensionality. *Structural Equation Modeling*, *23*, 116-139.

Morin, A.J.S., Arens, K., Tran, A., & Caci, H. (2016b). Exploring sources of construct-relevant multidimensionality in psychiatric measurement: A tutorial and illustration using the Composite Scale of Morningness. *International Journal of Methods in Psychiatric Research*, *25*, 277-288.

Morin, A.J.S., Boudrias, J.-S., Marsh, H.W., Madore, I., & Desrumeaux, P. (2016). Further reflections on disentengling shape and level effects in person-centered analyses: An illustration exploring the dimensionality of psychological health. *Structural Equation Modeling, 23*, 438-454.

Morin, A.J.S., Boudrias, J.-S., Marsh, H.W., McInerney, D.M., Dagenais-Desmarais, V., Madore, I., & Litalien, D. (2017). Complementary variable- and person-centered approaches to the dimensionality of psychometric constructs: Application to psychological wellbeing at work. *Journal of Business and Psychology, 32*, 395-419.

Morin, A.J.S., Marsh, H.W., & Nagengast, B. (2013). Exploratory structural equation modeling. In G.R. Hancock & R.O. Mueller (Eds.), *Structural equation modeling: a second course* (pp. 395–436). Charlotte: Information Age.

Morin, A.J.S., Maïano, C., White, R.L., Owen, K.B., Tracey, D., Mascret, N., & Lonsdale, C. (2016). English validation of the short form of the Physical Self-Inventory (PSI-S). *Psychology of Sport and Exercise*, *27*, 180-194.

Morin, A.J.S., Myers, N.D., & Lee, S. (in press). Modern factor analytic techniques: Bifactor models, exploratory structural equation modeling (ESEM) and bifactor-ESEM. In G. Tenenbaum, & Eklund, R.C. (Eds.), *Handbook of Sport Psychology*, 4th Edition. Wiley.

Millsap, R.E. (2011). *Statistical approaches to measurement invariance*. New York: Taylor & Francis.

Murray, A.L., & Johnson, W. (2013). The limitations of model fit in comparing the bi-factor versus higher-order models of human cognitive ability structure. *Intelligence*, *41*, 407–422.

Muthén, L.K., & Muthén, B.O. (1998-2015). *Mplus User's Guide. Seventh Edition*. Los Angeles, CA: Muthén & Muthén.

Myers, N.D., Martin, J.J., Ntoumanis, N., Celimli, S., & Bartholomew, K.J. (2014). Exploratory bifactor analysis in sport, exercise, and performance psychology: A substantive-methodological synergy. *Sport, Exercice, & Performance Psychology, 3*, 258-272.

Neubauer, A.B., & Voss, A. (2016). Validation and revision of a German version of the balanced measure of psychological needs scale. *Journal of Individual Differences*, *37*, 56-72.

Neubauer, A.B., & Voss, A. (2017). The structure of need fulfillment: Separating need satisfaction and dissatisfaction on between- and within-person level. *European Journal of Psychological*

*Assessment*, *37*, 56-72. Early view doi: 10.1027/1015-5759/a000326

Nishimura, T., & Suzuki, T. (2016). Basic psychological need satisfaction and frustration in Japan: Controlling for the Big Five personality traits. *Japanese Psychological Research*, *58*, 320-331.

OECD (2014). *Enhancing Women's Economic Empowerment through Entrepreneurship and Business Leadership in OECD Countries, Background Report*. www.oecd.org/gender/

OECD (2017). *Gender wage gap (indicator)*. data.oecd.org/earnwage/gender-wage-gap.htm

Reise, S. P. (2012). The rediscovery of bifactor measurement models. *Multivariate Behavioral Research, 47*, 667-696.

Ren, J., Wu, Y. D., Chan, J. S., & Yan, J. H. (2013). Cognitive aging affects motor performance and learning. *Geriatrics & gerontology international, 13*, 19-27.

Rocchi, M., Pelletier, L., Cheung, S., Baxter, D., & Beaudry, S. (2017). Assessing need-supportive and need-thwarting interpersonal behaviours: The Interpersonal Behaviours Questionnaire (IBQ). *Personality & Individual Differences, 104,* 423-433.

Rodriguez, A., Reise, S. P., & Haviland, M. G. (2016). Evaluating bifactor models: Calculating and interpreting statistical indices. *Psychological Methods*, *21*, 137-150.

Ryan, R.M. (2005). The developmental line of autonomy in the etiology, dynamics, and treatment of borderline personality disorders. *Development and Psychopathology, 17*, 987-1006.

Ryan, R.M., Deci, E.L., Grolnick, W.S., & La Guardia, J.G. (2006). The significance of autonomy and autonomy support in psychological development and psychopathology. In D. Cicchetti, & D.J. Cohen (Eds.), *Developmental psychopathology: Theory and method, Vol. 1, 2nd ed.* (pp. 795-849). Hoboken, NJ: John Wiley & Sons Inc.

Sànchez-Oliva, D., Morin, A.J.S., Teixeira, P.J., Carraça, E.V., Palmeira, A.L., & Silva, M.N. (2017). A bifactor-exploratory structural equation modeling representation of the structure of basic psychological needs at work scale. *Journal of Vocational Behavior, 98*, 173-187.

Schmitt, D.P., & Allik, J. (2005). Simultaneous administration of the Rosenberg self-esteem scale in 53 nations: exploring the universal and culture-specific features of global self-esteem. *Journal of Personality & Social Psychology, 89*, 623–642.

Sheldon, K.M., & Hilpert, J. (2012). The balanced measure of psychological needs (BMPN) scale: An alternative domain general measure of need satisfaction. *Motivation and Emotion*, *36*, 439-451.

Sijtsma, K. (2009). On the use, misuse, and the very limited usefulness of Cronbach's alpha. *Psychometrika*, *74*, 107-120.

Steenkamp, J.E., & Baumgartner, H. (1998). Assessing measurement invariance in cross-national consumer research. *Journal of Consumer Research*, *25*, 78-90.

Van den Broeck, A., Ferris, D.L., Chang, C.H., & Rosen, C.C. (2016). A review of self-determination theory's basic psychological needs at work. *Journal of Management*, *42*, 1195-1229.

Vansteenkiste, M., Niemiec, C.P., & Soenens, B. (2010). The development of the five mini-theories of self-determination theory: An historical overview, emerging trends, and future directions. In S. Karabenick and T.C. Urdan (Eds.), *The decade ahead: Theoretical perspectives on motivation and achievement* (pp. 105-165). Bingley, UK: Emerald.

Vansteenkiste, M., & Ryan, R.M. (2013). On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. *Journal of Psychotherapy Integration*, *23*, 263-280.

Vlachopoulos, S.P. (2008). The Basic Psychological Needs in Exercise Scale: Measurement invariance over gender. *Structural Equation Modeling*, *15*, 114–135.

Watkins, D., & Cheung, S. (1995). Culture, gender, and response bias: An analysis of responses to the self-description questionnaire. *Journal of Cross-Cultural Psychology*, *26*, 490–504.

Wilson, P.M., Rogers, W.T., Rodgers, W.M., & Wild, T.C. (2006). The Psychological Need Satisfaction in Exercise Scale. *Journal of Sport & Exercise Psychology*, *28*, 231–251.

World Economic Forum (2016). *Closing the Economic Gender Gap: Learning from the Gender Parity Task Forces.* www3.weforum.org/docs/WEF_2016_Closing_the_Economic_Gender_Gap.pdf .

Yuan, K.-H., Chan, W., Marcoulides, G.A., & Bentler, P. (2016). Assessing structural equation models by equivalence testing with adjusted fit indices. *Structural Equation Modeling*, *23*, 319-330.

Marcoulides, K.M., & Yuan, K.-H. (2017). New ways to evaluate goodness-of-fit: A note on using equivalence testing to assess structural equation models. *Structural Equation Modeling*, *24*, 148-153.

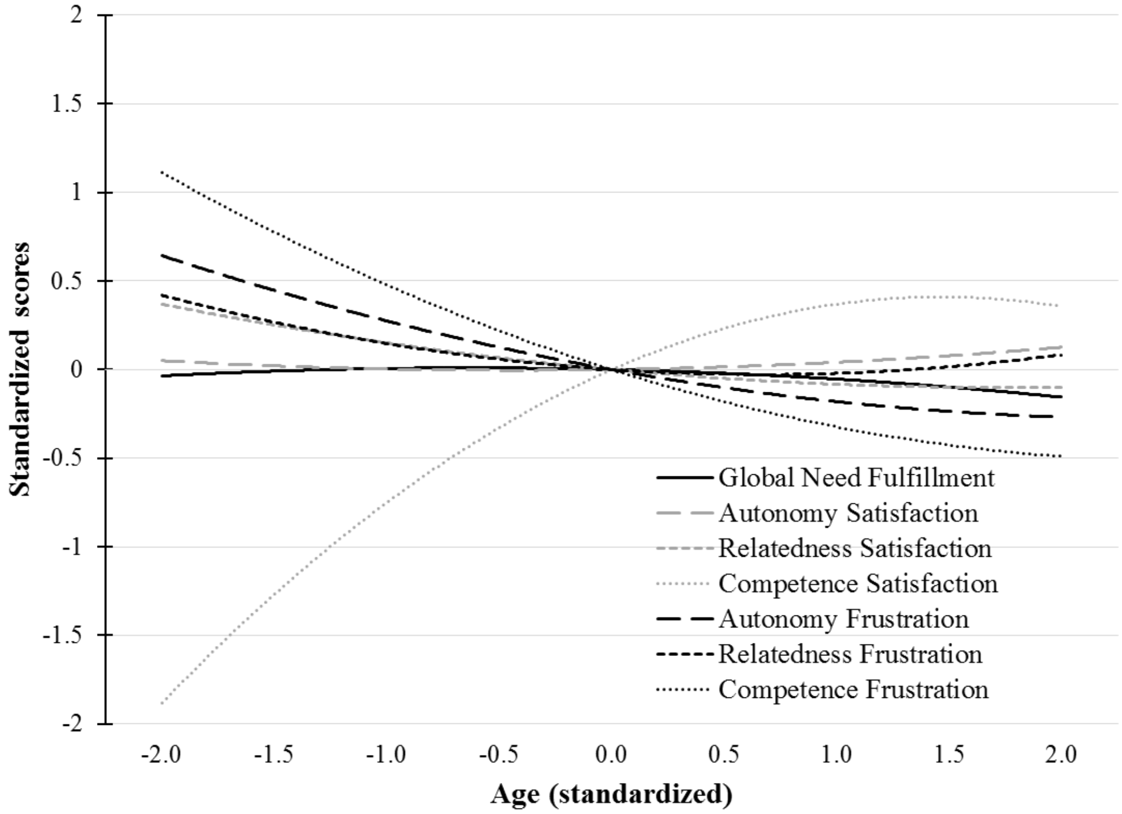


**Figure 1**

*Standardized Relations between Age and the Basic Psychological Needs Satisfaction and Frustration Scales*

**Table 1**

*Goodness-of-Fit Statistics for the Estimated Models on the Basic Psychological Need Satisfaction and Frustration Scale*

| Model | $\chi^2$ | df | CFI | TLI | RMSEA | RMSEA 90% CI |
|---|---|---|---|---|---|---|
| *Sample 1* | | | | | | |
| Model 1. One-factor CFA (Fu) | 6585.623* | 252 | .654 | .621 | .105 | .102-.107 |
| Model 2. Two-factor CFA (S, Fr) | 5592.909* | 251 | .708 | .679 | .096 | .094-.098 |
| Model 3. Two-factor ESEM (S, Fr) | 3836.505* | 229 | .803 | .763 | .083 | .080-.085 |
| Model 4. Three-factor CFA (A, C, R) | 3271.539* | 249 | .835 | .817 | .073 | .070-.075 |
| Model 5. Three-factor ESEM (A, C, R) | 2118.053* | 207 | .896 | .861 | .063 | .061-.066 |
| Model 6. Six-factor CFA (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) | 1188.206* | 237 | .948 | .940 | .042 | .039-.044 |
| Model 7. Six-factor ESEM (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) | 399.332* | 147 | .986 | .974 | .027 | .024-.031 |
| Model 8. B-CFA: Two S-factors (S, Fr) and one G-factor (Fu) | 3374.522* | 228 | .828 | .792 | .077 | .075-.080 |
| Model 9. B-ESEM: Two S-factors (S, Fr) and one G-factor (Fu) | 2118.053* | 207 | .896 | .861 | .063 | .061-.066 |
| Model 10. B-CFA: Three S-factors (A, C, R) and one G-factor (Fu) | 2699.663* | 228 | .865 | .837 | .069 | .066-.071 |
| Model 11. B-ESEM: Three S-factors (A, C, R) and one G-factor (Fu) | 1038.773* | 186 | .953 | .931 | .045 | .042-.047 |
| Model 12. B-CFA: Three S-factors (A, C, R) and two G-factors (S, Fr) | 970.644* | 227 | .959 | .951 | .038 | .035-.040 |
| Model 13. B-ESEM: Three S-factors (A, C, R) and two G-factors (S, Fr) | 754.956* | 182 | .969 | .953 | .037 | .034-.040 |
| Model 14. B-CFA: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and one G-factor (Fu) | 2001.200* | 228 | .903 | .883 | .058 | .056-.060 |
| Model 15. B-ESEM: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and one G-factor (Fu) | 235.065* | 129 | .994 | .988 | .019 | .015-.023 |
| Model 16. B-CFA: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and two G-factor (S, Fr) | 1894.592* | 227 | .909 | .889 | .057 | .054-.059 |
| Model 17. B-ESEM: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and two G-factor (S, Fr) | 233.641* | 122 | .994 | .986 | .020 | .016-.024 |
| Model 1. One-factor CFA (Fu) | 2134.789* | 252 | .584 | .544 | .122 | .117-.127 |
| Model 2. Two-factor CFA (S, Fr) | 1229.723* | 251 | .784 | .762 | .088 | .083-.093 |
| Model 3. Two-factor ESEM (S, Fr) | 1202.512* | 229 | .785 | .741 | .092 | .087-.097 |
| Model 4. Three-factor CFA (A, C, R) | 1817.230* | 249 | .653 | .616 | .112 | .107-.117 |
| Model 5. Three-factor ESEM (A, C, R) | 559.913* | 207 | .922 | .896 | .058 | .052-.064 |
| Model 6. Six-factor CFA (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) | 421.424* | 237 | .959 | .953 | .039 | .033-.045 |
| Model 7. Six-factor ESEM (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) | 182.441 | 147 | .992 | .985 | .022 | .008-.032 |
| Model 8. B-CFA: Two S-factors (S, Fr) and one G-factor (Fu) | 728.411* | 228 | .889 | .866 | .066 | .061-.071 |
| Model 9. B-ESEM: Two S-factors (S, Fr) and one G-factor (Fu) | 559.913* | 207 | .922 | .896 | .058 | .052-.064 |
| Model 10. B-CFA: Three S-factors (A, C, R) and one G-factor (Fu) | 952.445* | 228 | .840 | .806 | .079 | .074-.085 |
| Model 11. B-ESEM: Three S-factors (A, C, R) and one G-factor (Fu) | 304.721* | 186 | .974 | .961 | .036 | .028-.043 |
| Model 12. B-CFA: Three S-factors (A, C, R) and two G-factors (S, Fr) | 385.084* | 227 | .965 | .958 | .037 | .031-.043 |
| Model 13. B-ESEM: Three S-factors (A, C, R) and two G-factors (S, Fr) | 253.986* | 182 | .984 | .976 | .028 | .019-.036 |
| Model 14. B-CFA: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and one G-factor (Fu) | 787.230* | 228 | .876 | .850 | .070 | .064-.075 |
| Model 15. B-ESEM: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and one G-factor (Fu) | 147.144 | 129 | .996 | .991 | .017 | .000-.028 |
| Model 16. B-CFA: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and two G-factor (S, Fr) | 535.019* | 227 | .932 | .917 | .052 | .046-.058 |
| Model 17. B-ESEM: Six S-factors (A-S, A-Fr, C-S, C-Fr, R-S, R-Fr) and two G-factor (S, Fr) | DNC | | | | | |

*Note.* CFA: Confirmatory factor analysis; ESEM: Exploratory structural equation modeling; B: Bifactor model; Fu: Global need fulfillment; S: Need satisfaction; Fr: Need frustration; A: Need for autonomy; C: Need for competence; R: Need for relatedness; G-factor: Global factor estimated as part of a bifactor model; S-factor: Specific factor estimated as part of a bifactor model; $\chi^2$: Robust chi-square test of exact fit; df: Degrees of freedom; CFI: Comparative fit index; TLI: Tucker-Lewis index; RMSEA: Root mean square error of approximation; 90% CI: 90% confidence interval of the RMSEA; DNC: Did not converge, suggesting overparameterization; *$p$ < 0.01.

**Table 2**

*Standardized Parameter Estimates (and Standard Errors in Parentheses) from the Bifactor-ESEM Solution Including Six S-Factors and One G-Factor in Study 1*

| | Fu (λ) | A-S (λ) | R-S (λ) | C-S (λ) | A-Fr (λ) | R-Fr (λ) | C-Fr (λ) | δ |
|---|---|---|---|---|---|---|---|---|
| Autonomy satisfaction (A-S) | | | | | | | | |
| Item 1 | **.470(.022)**** | **.284(.034)**** | .040(.025) | .105(.027)** | -.099(.026)** | .050(.026) | .080(.028)** | .667 |
| Item 7 | **.574(.021)**** | **.562(.043)**** | .036(.017)* | .052(.019)** | .000(.018) | .056(.019)** | -.042(.021) | .346 |
| Item 13 | **.596(.022)**** | **.549(.048)**** | .026(.018) | .037(.019) | .056(.017)** | .081(.019)** | .026(.022) | .330 |
| Item 19 | **.638(.039)**** | **.137(063)*** | -.060(.030)* | -.063(.051) | -.040(.039) | .217(.039)** | .259(.042)** | .452 |
| Relatedness satisfaction (R-S) | | | | | | | | |
| Item 3 | **.432(.024)**** | .051(.027) | **.352(.026)**** | -.006(.029) | .005(.025) | -.278(.026)** | .077(.028)** | .604 |
| Item 9 | **.442(.023)**** | .005(.017) | **.685(.029)**** | .026(.017) | .051(.016)** | -.114(.022)** | .026(.018) | .319 |
| Item 15 | **.502(.021)**** | .001(.017) | **.684(.027)**** | -.047(.018)** | .071(.015)** | -.130(.021)** | .016(.018) | .256 |
| Item 21 | **.465(.024)**** | .046(.027) | **.346(.030)**** | -.054(.031) | .055(.023)* | -.233(.029)** | .223(.037)** | .551 |
| Competence satisfaction (C-S) | | | | | | | | |
| Item 5 | **.624(.019)**** | .049(.019)* | -.031(.018) | **.522(.032)**** | .047(.017)** | .042(.018)* | -.158(.023)** | .306 |
| Item 11 | **.657(.021)**** | .019(.027) | -.030(.023) | **.294(.041)**** | .082(.025)** | .161(.023)** | -.004(.028) | .448 |
| Item 17 | **.637(.021)**** | .100(.027)** | .014(.023) | **.154(.040)**** | .096(.023)** | .116(.025)** | .019(.030) | .538 |
| Item 23 | **.663(.022)**** | .070(.021)** | -.036(.021) | **.346(.043)**** | .085(.022)** | .145(.025)** | -.146(.026)** | .385 |
| Autonomy frustration (A-Fr) | | | | | | | | |
| Item 2 | **-.221(.025)**** | .055(.025)* | .036(.023) | .074(.026)** | **.402(.028)**** | .101(.025)** | .062(.025)* | .766 |
| Item 8 | **-.480(.022)**** | -.050(.022)* | .050(.019)* | .071(.025)** | **.527(.032)**** | .006(.020) | -.001(.020) | .482 |
| Item 14 | **-.466(.021)**** | .000(.017) | .073(.017)** | -.040(.022) | **.625(.036)**** | .030(.018) | .088(.019)** | .376 |
| Item 20 | **-.580(.020)**** | .003(.028) | .056(.022)* | .161(.026)** | **.318(.031)**** | .039(.026) | .037(.024) | .531 |
| Relatedness frustration (R-Fr) | | | | | | | | |
| Item 4 | **-.491(.022)**** | .077(.022)** | -.050(.022)* | .048(.024)* | .023(.021) | **.495(.031)**** | .020(.025) | .503 |
| Item 10 | **-.465(.025)**** | .063(.026)* | -.276(.026)** | .066(.030)* | .049(.023)* | **.478(.032)**** | .094(.030)** | .460 |
| Item 16 | **-.506(.025)**** | .076(.022)** | -.158(.023)** | .065(.023)** | .025(.020) | **.532(.030)**** | .005(.028) | .425 |
| Item 22 | **-.491(.025)**** | .032(.026) | -.291(.025)** | .133(.029)** | .074(.024)** | **.359(.031)**** | .068(.031)* | .517 |
| Competence frustration (C-Fr) | | | | | | | | |
| Item 6 | **-.582(.021)**** | .009(.025) | .119(.022)** | -.304(.025)** | .095(.023)** | .091(.023)** | **.324(.035)**** | .433 |
| Item 12 | **-.657(.018)**** | .056(.020)* | .065(.018)** | -.033(.025) | .058(.019)** | .047(.022)* | **.392(.030)**** | .400 |
| Item 18 | **-.651(.022)**** | .053(.025)* | .127(.020)** | -.139(.038)** | .078(.025)** | .022(.026) | **.302(.032)**** | .440 |
| Item 24 | **-.657(.019)**** | .019(.020) | .069(.019)** | .051(.025)* | .031(.020) | .062(.023)** | **.437(.034)**** | .365 |

*Note*. *$p$ < .05; **$p$ < .01; CFA: Confirmatory factor analysis; ESEM: Exploratory structural equation modeling; Fu: Global (G-Factor) representing need fulfillment; S-Factors: Specific factors from the bifactor model; S: Need satisfaction; Fr: Need frustration; A: Need for autonomy; C: Need for competence; R: Need for relatedness; λ: Factor loading; δ: Item uniqueness; Target factor loadings are in bold.

**Table 3**

*Tests of Measurement Invariance and Differential Item Functioning for the Final Retained Model (Model 15)*

| Model | $\chi^2$ (df) | CFI | TLI | RMSEA | 90% CI | Comparison | $\Delta\chi^2$ (df) | ΔCFI | ΔTLI | ΔRMSEA |
|---|---|---|---|---|---|---|---|---|---|---|
| *Sample invariance* | | | | | | | | | | |
| Configural invariance | 377.313 (258)* | .995 | .989 | .018 | .014-.022 | — | — | — | — | — |
| Weak invariance | 600.080 (377)* | .990 | .985 | .021 | .017-.024 | Configural | 22.285 (119)* | -.005 | -.004 | +.003 |
| Strong invariance | 826.316 (394)* | .981 | .973 | .028 | .025-.031 | Weak | 555.843 (17)* | -.009 | -.012 | +.007 |
| Partial strong invariance | 759.790 (393)* | .984 | .977 | .026 | .023-.029 | Weak | 521.101 (16)* | -.006 | -.008 | +.005 |
| Strict invariance | 842.362 (417)* | .981 | .975 | .027 | .024-.030 | Partial Strong | 66.296 (24)* | -.003 | -.002 | +.001 |
| Latent variance-covariance invariance | 971.625 (445)* | .977 | .971 | .029 | .027-.032 | Strict | 112.078 (28)* | -.004 | -.004 | +.002 |
| Latent means invariance | 1051.602 (452)* | .973 | .967 | .031 | .028-.033 | Var-Covar. | 6.526 (7)* | -.004 | -.004 | +.002 |
| *Gender invariance* | | | | | | | | | | |
| Configural invariance | 449.768 (258)* | .992 | .982 | .023 | .019-.027 | — | — | — | — | — |
| Weak invariance | 566.923 (377)* | .992 | .988 | .019 | .016-.022 | Configural | 126.335 (119) | .000 | +.006 | -.004 |
| Strong invariance | 628.457 (394)* | .990 | .986 | .021 | .018-.024 | Weak | 7.915 (17)* | -.002 | -.002 | +.002 |
| Strict invariance | 694.746 (418)* | .988 | .984 | .022 | .019-.025 | Strong | 58.688 (24) | -.002 | -.002 | +.001 |
| Latent variance-covariance invariance | 819.121 (446)* | .984 | .980 | .024 | .022-.027 | Strict | 108.480 (28)* | -.004 | -.004 | +.002 |
| Latent means invariance | 939.212 (453)* | .979 | .974 | .028 | .025-.030 | Var-Covar. | 129.601 (7)* | -.005 | -.006 | +.004 |
| *MIMIC models* | | | | | | | | | | |
| MM1. MIMIC Null | 1446.214 (549)* | .963 | .956 | .034 | .032-.036 | — | — | — | — | — |
| MM2. MIMIC saturated | 869.357 (453)* | .983 | .975 | .026 | .023-.028 | Null | 669.751 (96)* | +.020 | +.019 | -.008 |
| MM3. MIMIC invariant | 1169.776 (521)* | .973 | .967 | .030 | .028-.032 | Saturated | 337.718 (68)* | -.010 | -.008 | +.004 |
| MM4. MIMIC gender equality | 1232.712 (535)* | .971 | .965 | .030 | .028-.033 | Invariant | 68.496 (14) | -.002 | -.002 | .000 |

*Note.* *$p$ < .01; MIMIC: Multiple indicators multiple causes model; $\chi^2$: Robust chi-square test of exact fit; df: Degrees of freedom; CFI: Comparative fit index; TLI: Tucker-Lewis index; RMSEA: Root mean square error of approximation; 90% CI: 90% confidence interval of the RMSEA; $\Delta\chi^2$ = Robust (Satorra-Bentler) chi-square difference test (calculated from loglikelihood for greater precision); Δ: change in model fit in relation to the comparison model.

**Table 4**

*Effects of Age on the Factors from the Final Multiple Indicators Multiple Causes Model*

| | Age (linear effect) | | | Age$^2$ (quadratic effect) | | |
|---|---|---|---|---|---|---|
| Factor | *b* (s.e.) | $\beta_{male}$ | $\beta_{female}$ | *b* (s.e.) | $\beta_{male}$ | $\beta_{female}$ |
| Global need fulfillment | -.03 (.09) | -.03 | -.03 | -.02 (.02) | -.05 | -.05 |
| Autonomy satisfaction | .02 (.14) | .02 | .02 | .02 (.04) | .05 | .04 |
| Relatedness satisfaction | -.12 (.07) | -.12 | -.11 | .03 (.03) | .08 | .07 |
| Competence satisfaction | .56** (.20) | .57 | .51 | -.19** (.05) | -.41 | -.37 |
| Autonomy frustration | -.23** (.09) | -.24 | -.22 | .05 (.03) | .10 | .09 |
| Relatedness frustration | -.08 (.12) | -.09 | -.08 | .06 (.04) | .14 | .13 |
| Competence frustration | -.40** (.14) | -.41 | -.37 | .08* (.09) | .17 | .15 |

*Note.* *$p$<.05; **$p$<.01*B:* Unstandardized regression coefficients; s.e.: Standard error of the coefficient; $\beta$: Standardized regression coefficients (although these values are highly similar due to the equality constraints, there are still minor differences as a result of the variability within each group).

***Online Supplements for:***

# Investigating the Multidimensionality of Need Fulfillment: A Bifactor Exploratory Structural Equation Modeling Representation

## Appendix 1

### Hungarian and original English version of the Basic Psychological Need Satisfaction and Frustration Scale – General Measure

| | **Hungarian Version** | **English Version (Chen et al., 2015)** |
|---|---|---|
| Title | Alapvető pszichológiai szükségletek kielégítettsége és frusztrációja | Basic Psychological Need Satisfaction and Frustration Scale – General Measure |
| Instructions | Az alábbiakban olyan állításokat olvashatsz, amelyek az általános tapasztalataidra és érzéseidre vonatkoznak.<br>Olvasd el ezeket a mondatokat alaposan és az 1-től 5-ig terjedő skálán jelöld be, hogy mennyire igazak rád abban az életszakaszban, amelyben vagy.<br>Válaszolj a lehető legőszintébben! | Below, we are going to ask about your actual experiences of certain feelings in your life.<br>Please read each of the following items carefully. You can choose from 1 to 5 to indicate the<br>degree to which the statement is true for you at this point in your life. |
| Rating Scale | 1 – egyáltalán nem igaz rám<br>2 –<br>3 –<br>4 –<br>5 – teljesen igaz rám | 1 – not true at all<br>2 –<br>3 –<br>4 –<br>5 – completely true |
| Item 1 (Autonomy Satisfaction) | A döntésem szabadságát érzem azokban a dolgokban, amelyeket elvállalok. | I feel a sense of choice and freedom in the things I undertake. |
| Item 2 (Autonomy Frustration) | A legtöbb dolgot azért csinálom, mert úgy érzem, hogy ezt „kell” tennem. | Most of the things I do feel like “I have to”. |
| Item 3 (Relatedness Satisfaction) | Úgy érzem, hogy azok az emberek, akikkel törődök, viszonozzák a törődést. | I feel that the people I care about also care about me. |
| Item 4 (Relatedness Frustration) | Úgy érzem, hogy nem fogad be az a csoport, ahova tartozni szeretnék. | I feel excluded from the group I want to belong to. |
| Item 5 (Competence Satisfaction) | Biztos vagyok benne, hogy jól meg tudom csinálni a dolgaim. | I feel confident that I can do things well. |
| Item 6 (Competence Frustration) | Komoly kétségeim vannak azzal kapcsolatban, hogy jól el tudom látni a teendőim. | I have serious doubts about whether I can do things well. |
| Item 7 (Autonomy Satisfaction) | Úgy érzem, hogy a döntéseim tükrözik azt, amit igazából akarok. | I feel that my decisions reflect what I really want. |
| Item 8 (Autonomy Frustration) | Úgy érzem, hogy sok olyan dolgot vagyok kénytelen megcsinálni, amit amúgy magamtól nem választanék. | I feel forced to do many things I wouldn’t choose to do. |

| | **Hungarian Version** | **English Version (Chen et al., 2015)** |
|---|---|---|
| Item 9 (Relatedness Satisfaction) | Közel állok azokhoz az emberekhez, akik törődnek velem, és akikkel én törődöm. | I feel connected with people who care for me, and for whom I care. |
| Item 10 (Relatedness Frustration) | Úgy érzem, hogy a számomra fontos emberek távolságtartóak velem. | I feel that people who are important to me are cold and distant towards me. |
| Item 11 (Competence Satisfaction) | Úgy érzem, hogy értek ahhoz, amit csinálok. | I feel capable at what I do. |
| Item 12 (Competence Frustration) | Csalódott vagyok a legtöbb teljesítményemmel kapcsolatban. | I feel disappointed with many of my performance. |
| Item 13 (Autonomy Satisfaction) | Úgy érzem, hogy a döntéseim azt fejezik ki, aki igazán vagyok. | I feel my choices express who I really am. |
| Item 14 (Autonomy Frustration) | Túl sok dolognál érzem azt a nyomást, hogy meg kell csinálnom. | I feel pressured to do too many things. |
| Item 15 (Relatedness Satisfaction) | Szoros kapcsolatban vagyok azokkal az emberekkel, akik fontosak nekem. | I feel close and connected with other people who are important to me. |
| Item 16 (Relatedness Frustration) | Az a benyomásom, hogy nem kedvelnek azok az emberek, akikkel sok időt töltök. | I have the impression that people I spend time with dislike me. |
| Item 17 (Competence Satisfaction) | Úgy érzem, hogy tudom hogyan érhetem el a céljaim. | I feel competent to achieve my goals. |
| Item 18 (Competence Frustration) | Bizonytalan vagyok a képességeimmel kapcsolatban. | I feel insecure about my abilities. |
| Item 19 (Autonomy Satisfaction) | Úgy érzem, hogy azt csinálom, ami tényleg érdekel engem. | I feel I have been doing what really interests me. |
| Item 20 (Autonomy Frustration) | Miközben végzem a mindennapi teendőim, úgy érzem meg van kötve a kezem. | My daily activities feel like a chain of obligations. |
| Item 21 (Relatedness Satisfaction) | Kellemesen érzem magam azokkal az emberekkel, akikkel sok időt töltök. | I experience a warm feeling with the people I spend time with. |
| Item 22 (Relatedness Frustration) | Úgy érzem, hogy a kapcsolataim felszínesek. | I feel the relationships I have are just superficial. |
| Item 23 (Competence Satisfaction) | Úgy érzem, hogy a nehéz feladatokkal is sikeresen meg tudok birkózni. | I feel I can successfully complete difficult tasks. |
| Item 24 (Competence Frustration) | Sikertelennek érzem magam a korábbi hibáim miatt. | I feel like a failure because of the mistakes I make. |

**Appendix 2, Table S1**

*Standardized Parameter Estimates (and Standard Error in Parentheses) from the Six-Factor CFA and ESEM Solutions in Study 1*

| | CFA | | ESEM | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Factor (λ) | δ | AS (λ) | RS (λ) | CS (λ) | AF (λ) | RF (λ) | CF (λ) | δ |
| Autonomy satisfaction (A-S) | | | | | | | | | |
| Item 1 | **.578(.020)**** | .666 | **.398(.040)**** | .045(.035) | .162(.040)** | -.156(.032)** | .001(.039) | .087(.041)* | .668 |
| Item 7 | **.775(.015)**** | .400 | **.764(.053)**** | -.002(.027) | -.023(.050) | .033(.023) | .014(.037) | -.113(.029)** | .389 |
| Item 13 | **.793(.013)**** | .371 | **.856(.051)**** | -.023(.024) | -.016(.041) | .086(.022)** | -.006(.029) | -.065(.024)* | .311 |
| Item 19 | **.622(.018)**** | .614 | **.411(.055)**** | .057(.043) | .201(.080)* | -.245(.034)** | .050(.052) | .124(.078) | .582 |
| Relatedness satisfaction (R-S) | | | | | | | | | |
| Item 3 | **.622(.018)**** | .613 | .083(.032)** | **.351(.036)**** | .053(.039) | -.014(.030) | -.301(.040)** | .068(.042) | .606 |
| Item 9 | **.791(.016)**** | .374 | -.054(.025)* | **.845(.043)**** | .079(.030)** | .003(.020) | .046(.044) | .002(.028) | .337 |
| Item 15 | **.837(.013)**** | .299 | -.016(.028) | **.888(.038)**** | .009(.023) | .008(.018) | .044(.032) | -.064(.028)* | .241 |
| Item 21 | **.639(.020)**** | .592 | .156(.044)** | **.348(.044)**** | .103(.056) | -.022(.025) | -.327(.048)** | .227(.052)** | .558 |
| Competence satisfaction (C-S) | | | | | | | | | |
| Item 5 | **.775(.013)**** | .400 | -.005(.027) | .037(.029) | **.688(.062)**** | .031(.030) | -.039(.039) | -.168(.078)* | .349 |
| Item 11 | **.725(.015)**** | .474 | .103(.046)* | .089(.032)** | **.588(.063)**** | -.033(.025) | .024(.035) | -.065(.039) | .461 |
| Item 17 | **.663(.017)**** | .560 | .244(.043)** | .117(.037)** | **.381(.062)**** | -.009(.029) | .001(.045) | -.076(.055) | .557 |
| Item 23 | **.797(.012)**** | .364 | .111(.031)** | .082(.027)** | **.569(.044)**** | .021(.022) | .063(.032)* | -.219(.032)** | .376 |
| Autonomy frustration (A-Fr) | | | | | | | | | |
| Item 2 | **.433(.024)**** | .812 | .090(.032)** | .018(.032) | .107(.036)** | **.495(.034)**** | .051(.037) | .053(.039) | .768 |
| Item 8 | **.709(.016)**** | .498 | -.083(.026)** | -.014(.025) | .040(.027) | **.726(.030)**** | -.031(.028) | -.019(.031) | .463 |
| Item 14 | **.736(.016)**** | .458 | .051(.023)* | .021(.025) | -.043(.031) | **.750(.034)**** | -.024(.031) | .053(.050) | .424 |
| Item 20 | **.679(.018)**** | .539 | -.148(.033)** | -.012(.032) | .072(.049) | **.481(.036)**** | .088(.042)* | .142(.057)** | .553 |
| Relatedness frustration (R-Fr) | | | | | | | | | |
| Item 4 | **.656(.018)**** | .570 | -.018(.030) | .081(.032)* | -.043(.031) | .022(.024) | **.693(.049)**** | .060(.038) | .506 |
| Item 10 | **.738(.015)**** | .455 | .042(.035) | -.217(.040)** | .072(.049) | .024(.027) | **.525(.051)**** | .152(.050)** | .464 |
| Item 16 | **.729(.017)**** | .469 | .000(.028) | -.037(.035) | -.017(.034) | .020(.023) | **.707(.048)**** | .035(.034) | .422 |
| Item 22 | **.704(.016)**** | .504 | -.032(.027) | -.283(.033)** | .120(.034)** | .097(.029)** | **.380(.042)**** | .142(.041)** | .518 |
| Competence frustration (C-Fr) | | | | | | | | | |
| Item 6 | **.727(.016)**** | .471 | .047(.035) | .095(.038)* | -.367(.055)** | .091(.028)** | .147(.044)** | **.390(.066)**** | .454 |
| Item 12 | **.761(.013)**** | .422 | -.037(.038) | -.030(.026) | -.071(.037) | .089(.031)** | .070(.035)* | **.616(.056)**** | .402 |
| Item 18 | **.756(.012)**** | .429 | -.008(.027) | .052(.027) | -.257(.037)** | .132(.026)** | .097(.034)** | **.449(.041)**** | .441 |
| Item 24 | **.747(.014)**** | .442 | -.118(.035)** | -.018(.024) | .060(.055) | .046(.045) | .078(.046) | **.700(.106)**** | .373 |

*Note.* *$p$ < .05; **$p$ < .01; CFA: Confirmatory factor analysis; ESEM: Exploratory structural equation modeling; S: Need satisfaction; Fr: Need frustration; A: Need for autonomy; C: Need for competence; R: Need for relatedness; λ: Factor loading; δ: Item uniqueness; Target factor loadings are in bold.

**Appendix 2, Table S2**

*Latent Factor Correlations (and Standard Error in Parentheses) from from the Six-Factor CFA and ESEM Solutions in Study 1*

| | A-S | R-S | C-S | A-Fr | R-Fr | C-Fr |
|---|---|---|---|---|---|---|
| Autonomy satisfaction (A-S) | — | 0.440(.028) | 0.599(.050) | -0.455(.032) | -0.316(.041) | -0.417(.054) |
| Relatedness satisfaction (R-S) | 0.497(.026) | — | 0.262(.037) | -0.248(.026) | -0.635(.026) | -0.255(.048) |
| Competence satisfaction (C-S) | 0.763(.017) | 0.459(.025) | — | -0.376(.030) | -0.237(.031) | -0.590(.056) |
| Autonomy frustration (A-Fr) | -0.545(.028) | -0.319(.030) | -0.489(.026) | — | 0.431(.027) | 0.514(.057) |
| Relatedness frustration (R-Fr) | -0.405(.027) | -0.772(.024) | -0.424(.026) | 0.543(.024) | — | 0.429(.050) |
| Competence frustration (C-Fr) | -0.610(.022) | -0.394(.026) | -0.835(.019) | 0.692(.020) | 0.624(.020) | — |

Note. CFA: Confirmatory factor analysis; ESEM: Exploratory structural equation modeling; Values above the diagonal are from the ESEM model; Values below the diagonal are from the CFA model; All correlations are statistically significant ($p \leq .01$).

**Appendix 2, Table S3**

*Standardized Parameters (and Standard Error in Parentheses) from the Bifactor-ESEM Solution with Two General and Six Specific Factors in Study 1*

| | ESEM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | S (λ) | Fr (λ) | AS (λ) | RS (λ) | CS (λ) | AF (λ) | RF (λ) | CF (λ) | δ |
| Autonomy satisfaction (A-S) | | | | | | | | | |
| Item 1 | -.086(.142) | | .375(.080)** | .166(.043)** | .200(.072)** | -.267(.054)** | -.087(.034)* | -.201(.046)** | .665 |
| Item 7 | -.279(.203) | | .536(.161)** | .238(.062)** | .224(.055)** | -.187(.078)* | -.074(.038) | -.319(.081)** | .385 |
| Item 13 | -.408(.285) | | .560(.158)** | .271(.056)** | .286(.143)* | -.152(.050)** | -.072(.041) | -.257(.059)** | .271 |
| Item 19 | .015(.264) | | .560(.175)** | .091(.052) | .363(.137)* | -.230(.086)** | -.113(.038)** | .025(.136) | .480 |
| Relatedness satisfaction (R-S) | | | | | | | | | |
| Item 3 | .086(.149) | | .171(.038)** | .426(.037)** | .063(.081) | -.111(.035)** | -.397(.025)** | -.116(.076) | .595 |
| Item 9 | .162(.118) | | .115(.043)** | .759(.035)** | .139(.035)** | -.036(.030) | -.210(.035)** | -.073(.065) | .314 |
| Item 15 | .223(.184) | | .217(.027)** | .751(.045)** | .098(.119) | -.008(.031) | -.267(.033)** | -.093(.090) | .250 |
| Item 21 | .036(.109) | | .221(.042)** | .448(.034)** | .142(.066)* | -.089(.053) | -.404(.031)** | .042(.103) | .556 |
| Competence satisfaction (C-S) | | | | | | | | | |
| Item 5 | .077(.120) | | .158(.117) | .109(.037)** | .549(.206)** | -.177(.090)* | -.110(.037)** | -.539(.199)** | .322 |
| Item 11 | -.007(.441) | | .221(.311) | .149(.091) | .744(.321)* | -.120(.111) | -.088(.037)* | -.160(.076)* | .328 |
| Item 17 | .119(.213) | | .451(.050)** | .129(.052)* | .387(.108)** | -.087(.048) | -.147(.036)** | -.272(.154) | .512 |
| Item 23 | .102(.217) | | .319(.060)** | .101(.044)* | .535(.063)** | -.109(.046)* | -.073(.030)* | -.446(.094)** | .374 |
| Autonomy frustration (A-Fr) | | | | | | | | | |
| Item 2 | | .348(.098)** | -.060(.054) | -.020(.045) | -.005(.093) | .319(.110)** | .079(.038)* | .008(.086) | .767 |
| Item 8 | | .391(.121)** | -.287(.065)** | -.071(.028)* | -.123(.061)* | .514(.132)** | .076(.034)* | .040(.065) | .473 |
| Item 14 | | .463(.158)** | -.161(.057)** | -.051(.037) | -.187(.070)** | .567(.139)** | .044(.042) | .099(.105) | .389 |
| Item 20 | | .414(.052)** | -.356(.083)** | -.096(.031)** | -.190(.081)* | .298(.132)* | .179(.048)** | .044(.095) | .534 |
| Relatedness frustration (R-Fr) | | | | | | | | | |
| Item 4 | | .263(.064)** | -.097(.029)** | -.174(.024)** | -.108(.041)** | .081(.039)* | .591(.037)** | .152(.068)* | .501 |
| Item 10 | | .289(.056)** | -.034(.036) | -.398(.032)** | -.064(.040) | .066(.043) | .517(.039)** | .156(.042) | .457 |
| Item 16 | | .269(.060)** | -.073(.028)** | -.291(.024)** | -.111(.030)** | .076(.038)* | .616(.035)** | .112(.056)* | .427 |
| Item 22 | | .305(.051)** | -.126(.031)** | -.423(.026)** | -.097(.027)** | .069(.075) | .424(.040)** | .070(.038) | .513 |
| Competence frustration (C-Fr) | | | | | | | | | |
| Item 6 | | .293(.045)** | -.103(.093) | -.040(.024) | -.411(.129)** | .168(.046)** | .153(.027)** | .506(.116)** | .425 |
| Item 12 | | .471(.059)** | -.239(.035)** | -.124(.030)** | -.392(.059)** | .014(.099) | .143(.046)** | .364(.112)** | .398 |
| Item 18 | | .380(.054)** | -.213(.038)** | -.053(.024)* | -.462(.057)** | .097(.079) | .145(.036)** | .353(.100)** | .439 |
| Item 24 | | .510(.081)** | -.314(.038)** | -.114(.039)** | -.315(.135)** | -.048(.105) | .154(.053)** | .383(.197) | .357 |

*Note*. *$p$ < .05; **$p$ < .01; ESEM: Exploratory structural equation modeling; S: Need satisfaction; Fr: Need frustration; A: Need for autonomy; C: Need for competence; R: Need for relatedness; λ: Factor loading; δ: Item uniqueness; Target factor loadings are in bold.